The Corridors of Time · I ·

APES & MEN

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PREFACE

The extension of Charles Darwin's point of view to the interpretation of civilization is one of the most far-reaching changes in the intellectual life of our time. Anthropologists and geographers, archaeologists and historians have accumulated contributions in many fields, and the present writers feel that they should attempt a review of the more general aspects of these detailed studies. In doing so they wish to offer their tribute of appreciation to the efforts of Professors Breuil, Boule, Hoernes, Menghin, Myres, Obermaier, Osborn, and Sollas in this field. The growth of knowledge is so rapid that they cannot claim to be fully informed, nor can conclusions on many points attain a high degree of stability. It is, nevertheless, their hope that a considerable portion of the present work represents a fairly widespread consensus of opinion, and that the fresh suggestions embodied here and there may be useful in stimulating inquiry.

The work is in too condensed a form to allow of the inclusion of documentation, but the reader may follow this up in the volumes mentioned at the end of each chapter, and in books and papers by the authors, chiefly in the *Journal of the Royal Anthropological Institute* and in *Man*.

Many thanks are due to the authors, editors, and publishers of the following works and journals for permission to reproduce figures: *Epic of Creation*, by S. Langdon (Clarendon Press), for Fig. 1; *Textbook of Palaeontology*, vol. i, by K. von Zittel, for Fig. 7; *Evolution of Man*, by G. Elliot Smith (Oxford University Press), for Figs. 11, 41, 42, and 44; *Man and his Past*, by O. G. S. Crawford (Oxford University Press), for Fig. 47; J. Reid Moir, *Tertiary Man in England*, from *Natural History*,

vol. xxiv (American Museum of Natural History, New York), for Figs. 27, 31, and 32; *Proceedings of the Prehistoric Society of East Anglia*, vol. iii, for Fig. 30; *Textbook of European Archaeology*, vol. i, by R. A. S. MacAlister (Cambridge University Press), for Figs. 35 and 37; *Su l'origine dell' Uomo*, by V. Giuffrida Ruggeri (Nicola Zanichelli, Bologna), for Fig. 12; *Men of the Old Stone Age*, 3rd edition, by H. F. Osborn (Charles Scribner's Sons, New York), for Figs. 14 and 15; *Fossil Man in Spain*, by H. Obermaier (Yale University Press), for Figs. 17, 39, and 40; *A Guide to the Antiquities of the Stone Age in the Department of Medieval Antiquities*, 2nd edition (British Museum), for Fig. 26; *Ancient Hunters*, by W. J. Sollas (Macmillan & Co., Ltd.), for Figs. 19–21, 28, 29, 36, 38, 43, and 45; *Man's Place in Nature*, by T. H. Huxley (Macmillan & Co., Ltd.), for Fig. 13, and *Nature*, vol. cxv, 1925 (Macmillan & Co., Ltd.), for Fig. 16.

At the same time we wish to express our gratitude to the draughtsmen of the Clarendon Press for their courteous interest and the technical skill which they have devoted to the preparation of the numerous maps and charts.

H. J. E. P.
H. J. F.

20th December 1926.

CONTENTS

LIST OF ILLUSTRATIONS

I

The Origin of Man

Curiosity is deeply implanted in the human mind, and there are few peoples so backward that they have never asked themselves how mankind came into being. The replies to such questions are manifold, but may be divided into two groups: the first series conceives of man as having been derived, usually by divine intervention, from other animals or sometimes even from plants, while the other type relates how the creators made man, sometimes in their own image, from red clay or the dust of the earth. Occasionally, both ideas occur in the same story.

Many primitive peoples altogether discard the idea of the special creation of man, and believe that men in general and their own tribesmen in particular were descended from lower animals. This view is especially prevalent among totemic tribes, some of whom believe that their ancestors sprang from the animals and plants which they call their 'totems'.

For instance, some of the American Indians of California believe that they are descended from Coyotes or prairie wolves, and at one time ran on all fours; that by degrees one human character after another developed, until after passing through many stages, the perfect human form was reached. The cray-fish clan of the Choctaw Indians considers the cray-fish as their common ancestor, while the Osage Indians believe that they sprang from the progeny of a pair of beavers. Such cases may be multiplied on the American continent, and we meet with the same idea in Africa, where the Wanika tribe in East Africa look upon the hyaena as an ancestor; in the Malay peninsula, where some of the tribes believe themselves to be descended from the babacoote, a large lemur; and in New Guinea, where the Bukana consider themselves derived from sea-fish, white parrots, and other beasts. In Amboyna, one of the Molucca islands, some of the inhabitants say that they are descended from trees.

Of an intermediate type we may take as an example the story told by the Santals, a primitive tribe living in Bengal. According to the Rev. A. Campbell, D.D., they say that in the beginning there was a divine being called Thakur Jiu, but no land was visible, as all was covered with water. His servants then said to Thakur Jiu, 'How shall we make men?' to which he replied, 'If it be so desired, we can create them.' Then they said, 'If you give us a blessing, we shall be able to do so.' To which he answered, 'Go, call Malin Budhi. She is to be found in a rock cave beneath the water.' Having been summoned, Malin Budhi arose above the surface of the water and received orders to make two human beings.

How she made them is a matter of dispute, for some say she formed them of a kind of froth which issued from a supernatural being who lived at the bottom of the sea, while others assert that she made them of stiff clay. When they were finished she laid them out to dry, while Thakur Jiu looked on. While they were drying, the Day-horse came along, trampled on the figures and destroyed them. Later on Thakur Jiu asked Malin Budhi whether the figures were ready, and she replied, 'I made them, but I have many enemies.' When Thakur Jiu asked who they were, she answered, 'Who but the Day-horse?' Thakur Jiu then said, 'Kick the pieces into the Sora Nai and the Samud Nai.'

Later on, Thakur Jiu said to Malin Budhi, 'I again give you a blessing; go, make two human beings.' She prepared them as before, and took them to Thakur Jiu, who said, 'Well, have you got them ready?' She replied, 'They are ready; give them the gift of life.' He said to her, 'Above the door-frame is the life of birds; do not bring that. Upon the cross-beam is the life of human beings; bring it.' So she departed, but being small of stature she was unable to reach the cross-beam, so she brought the birds' life from above the door. She gave the birds' life to the figures, which immediately flew up to the heavens, where they continued to fly about for twelve months or twelve years. The names of the birds were Has and Hasin. After a time the birds desired to breed, so they went to Thakur Jiu and said, 'You gave us being, but we cannot find a place on which to rest.' He replied, 'I will prepare a place for you.'

Now in the water there were a sole-fish, a crab, Prince Earth-worm, and Lendon Kuar. These Thakur Jiu ordered to lift the earth above the water. The sole-fish said he would do so, but though he tried repeatedly, he failed. Then the crab tried, but failed also. Prince Earth-worm then undertook to perform the task which the others had found impossible. He dipped his head under the water and swallowed earth, which passed through him and came out at the other end, but, when it fell upon the surface of the water, it sank to the bottom again. So Prince Earth-worm said, 'Within the water resides Prince Tortoise; if we fasten him at the four corners with chains, and then raise the earth on his back, it will remain and not fall into the water again.' So Prince Earth-worm tied Prince Tortoise with chains, placed earth upon his back, and before long there was an island in the midst of the waters. Thakur Jiu then caused a *Karam* tree to grow on the island,

and *Sirom* grass and *Dhobi* grass and all kinds of trees and herbs, and the earth became firm and stable.

Then the birds Has and Hasin settled on the *Karam* tree and made their nest in the *Sirom* grass. There the hen bird laid two eggs, but Raghop Buar ate them. Then Has and Hasin flew to Thakur Jiu and complained to him that Raghop Buar had twice eaten their eggs. Thakur Jiu replied, 'I shall send some one to guard your eggs.' So he called Jaher-era and committed the eggs to her charge. She performed her task so well that the hen bird was able to hatch the eggs, and from them emerged two human beings, a male and a female. Their names were Pilchu Haram and Pilchu Budhi, and they were the parents of all mankind.

A somewhat similar tale is told by the Hopi or Moqui Indians who live in Arizona near the frontiers of Mexico. They believe that in the beginning there was nothing but water everywhere, and that two goddesses, named Huruing Wuhti, lived in houses on opposite sides of the ocean, one in the east and the other in the west. These two goddesses caused dry land to appear in the midst of the waters. But the sun, in his daily passage across the new earth, saw that there was nothing living upon it, and mentioned the fact to the two deities. So the two deities decided to meet, and the eastern goddess crossed the ocean on the rainbow to visit her colleague. After consultation, they decided to make a bird, and the eastern goddess made a wren of clay, which by means of their united incantations, came to life. Then the wren was sent to fly over the earth to see whether there was anything living upon it, but on his return he reported that there was none. So the two deities made many kinds of birds and beasts, and sent them to inhabit the earth. After a time the two goddesses decided to create men, so the eastern deity took clay, and out of it moulded first a woman and then a man, and the clay man and woman were given life in the same way as the birds and beasts.

All the above stories represent mankind as having been derived from some lower or simpler organism, or tell us that some such being preceded his advent and was instrumental in his first appearance. We must now turn to the other series, in which we find the deities directly responsible for the creation of man out of clay or other similar substances.

The Bila-an, a primitive tribe living in Mindanao, one of the Philippine islands, tell this tale, according to Mr. Fay-Cooper Cole, who visited them. They say that in the beginning there were four beings, two of them male and two female, who lived on a little island no bigger than a hat. The island was bare of vegetation, and the only other inhabitant was a bird. So the four beings, wishing to improve their surroundings, sent the bird to fetch soil, the fruit of the rattan and the fruit of other trees. When the bird had obeyed these commands, one of the male beings, Melu, took the soil and moulded it into land, just as a woman fashions a pot out of clay; in this he planted seeds which germinated and grew.

After a time, Melu said, 'Of what use is a land which has no people?' And the others said, 'Let us make wax into people.' They did so, and set them before the fire, where they melted. Finding that they could not make men out of wax, they decided to try dirt, and the two male beings set to work to do this. All went well till they came to the noses, when the creator responsible for this member put them on upside down. Melu pointed out to him his mistake, saying that the men would be drowned if their noses were left like that, but the creator declined to rectify the mistake, and went off in a huff. Melu lost no time in reversing the position of the noses, and thus they remain to this day, but on the bridges of every nose can be seen the imprint of the creator's fingers, as he finished in a hurry.

The Shilluks, who live on the White Nile, say that Juok, the creator, moulded all men out of earth, and that while doing so he wandered about. In one place he found pure white earth or sand, from which he made white men, when he came to Egypt he used Nile mud and made red or brown men, but when he reached the White Nile he found black earth, and so he made the Shilluks that colour.

His method of making man was this: taking a lump of earth, he said, 'I will make man, but he must be able to walk and run and go out into the fields, so I will give him two long legs, like the flamingo.' Having done this, he said, 'This man must be able to cultivate his millet, so I will give him two arms, one to hold the hoe, and the other to tear up the weeds.' Having given him two arms, he said, 'This man must be able to see his millet, so I will give him two eyes.' He did so, and then said, 'This man must be able to eat his millet, so I will give him a mouth.' When a mouth had been made, he said, 'This man must be able to dance and speak and sing and shout, and for these purposes he must have a tongue.' So a tongue was added, and the deity said, 'This man must be able to hear the noise of the dance and the speech of great men, and for that he needs two ears.' So two ears were given to him, and he was sent forth a perfect man.

These beliefs are simple, and in some ways childish, yet the stories told by more civilized peoples to account for their origin are often scarcely more profound. For instance, the ancient Egyptians related that Khnumu, the father of the gods and the deity of the Nile cataracts, moulded men out of clay on his potter's wheel. The Greeks, on the other hand, believed that Prometheus had moulded the first men out of clay at Panopeus in Phocis, and some of the clay left over might be seen in later days beside a ravine. Here Pausanias saw it in the second century of our era, and said that it smelt strongly of human flesh.

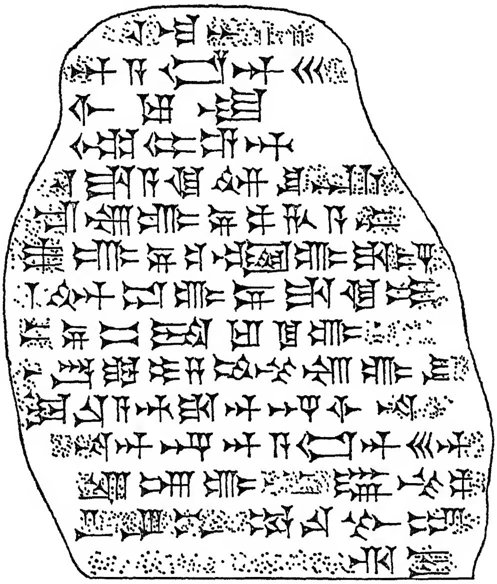

Fig. 1. A Babylonian tablet, recording part of the Creation story.

In Babylonia we get a somewhat more developed account, but not altogether unlike those already given. In the beginning, there was a watery waste, inhabited by two dragons, Apsu and Tiamat, and from this watery waste were born the gods. These wished to bring order out of chaos, but this project was displeasing to Apsu, who urged Tiamat to join with him in destroying the gods. The plot was overheard by Ea, the wisest of the gods, and by a stratagem he imprisoned Apsu and his servant Mummu. This enraged Tiamat, left alone in her watery waste, and she created huge monsters to assist her in destroying the gods.

The gods trembled at the approach of Tiamat and her vile progeny, but one of them, Marduk, sometimes called Bel or the Lord, faced the oncoming horde, caught them in a net and slew them. The body of Tiamat he split in twain; of one portion he made the sky and of the other the earth.

Then three of the gods, Anu, Ea, and Marduk, met together, and the two former praised the deeds of Marduk, but complained that the earth was uninhabited, and that there were no men there to build temples and worship the gods. To this Marduk replied that he would take his blood and bone and make men to dwell upon the earth and worship the gods. So at his request, Ea cut off the head of Marduk, and mixed the blood which flowed from his body with clay, from which they made men to worship the gods. A more recently published version states, however, that Ea and Marduk cut off the head of Kingu, the first-born of Tiamat, and made men from his blood.

Several stories of the creation of man seem to have been current at different times among the Hebrews. This people, for several centuries after their arrival in Palestine were ignorant of writing, and their account of the origin of man must have been handed down orally, as is the case with primitive tribes. During their intercourse with the Philistines, who are thought by some to have been refugees from Minoan Crete, it seems likely that they first learned the use of letters.

The first written records of theirs which have come down to us are believed to date from the eighth, or at the earliest, the ninth century before Christ, and among these is an account of the creation of man, relating how Yaweh, better known to us as Jah or Jehovah, the God of the Hebrews, or perhaps of the hill tribes of the Judaean highlands, formed man out of the dust of the ground, and breathed into his nostrils the breath of life. This account goes on to describe how this man was placed in a garden, and how in due course Yaweh, pitying his loneliness, abstracted a rib from his side, from which he made a woman to be a helpmeet to him. This account may be read in the second chapter of the Book of Genesis, beginning at the fourth verse.

Several centuries later, while the Hebrews were living captive in Babylonia, their priests put together their old records into a continuous story, and added many sections describing the events which had led to the ordaining of their ceremonies. This occurred about 500 B. C., and by that time the priests must have been familiar with the Babylonian legends and written histories, and had, perhaps, come into contact with the views of the Zoroastrian Persians.

In the account of the creation as written by the Jewish priests, we find several resemblances to the Babylonian story already given. It begins with the creation of heaven and earth, reminding us of the action of Marduk after he had slain Tiamat. Then follow successively the creation of the earth, vegetation, fish, birds, and mammals. It is significant that in this account the Creator is not the tribal God Yaweh, but Elohim, which, though usually translated God, means Gods, or rather the two Gods. After mammals had been created, the two Gods said, 'Let us make man in our own image, after our likeness.' And so the two Gods, who here remind us of Anu and Ea, or of Ea and Marduk, created man in their image, male and female.

During their captivity in Mesopotamia the Jewish priests added more and more to this sacred library, and after their return to Jerusalem in the reign of Cyrus, they looked upon this collection of works with the greatest veneration. The Greek king of Egypt, Ptolemy Philadelphus, was allowed to borrow a copy, which he caused to be translated by seventy scholars for his new library at Alexandria, and as time went on the books were considered more and more sacred. The early Christians, appreciating the high moral tone of the series, especially the books of the prophets, adopted the greater number of them, which they attached as a preliminary volume to their own sacred writings, and when these works came to be translated into the vulgar tongue at the Renaissance, the people looked upon them as written by God Himself, or at least verbally inspired by Him, and any further inquiry into the origin of man was deemed not only unnecessary, but actually impious.

During the last century, however, the attitude of educated men towards the Jewish scriptures has been undergoing a gradual change, the composite nature of the Bible has been demonstrated by Hebrew scholars, and geologists and biologists, archaeologists and anthropologists, anatomists and the students of folk-lore have been opening up the problem on every side. Much has been ascertained, but much remains to be discovered. We see the history of man's beginnings as yet but darkly, and the facts discovered are sometimes differently interpreted by various authorities.

In the following chapters we propose to give our readers an outline of the story which has been growing in recent years as the result of much scientific research; we hope to distinguish clearly between ascertained facts and hypothetical interpretations, and where more than one view is current, to state each as fairly as possible, leaving the reader to select that which most appeals to his judgement.

BOOKS TO CONSULT

FRAZER, Sir James George. *Folk-lore in the Old Testament* (3 vols., London, 1918), in which are given nearly all the creation stories.

FLEMING, Miss R. M. *Ancient Tales from many Lands* (London, 1922), in which some of these are charmingly told.

LANGDON, S. *The Babylonian Epic of Creation* (Oxford, 1923).

DRIVER, Canon S. R., D.D. *An Introduction to the Literature of the Old Testament* (Edinburgh, 1891).

2

An Introduction to the Earth's Story

THE past history of living things is enshrined in the geological record, in vast thicknesses of stratified rocks, laid down in successive ages as mud, sand, gravel, and shells in the beds of oceans, lakes, and rivers, and more rarely on the arid wastes of steppes and deserts. In these are embedded the remains of plants and animals that died while these beds were being deposited, and from these remains we can judge the nature of the fauna and flora of different regions of the earth in far distant epochs.

The geological record has been justly compared to a series of volumes, all of them illustrated, though some more profusely than others. The volumes may be considered as forming two series of which only scanty remains of the first have come down to us.

The first series has been termed Azoic or lifeless, because in it have been found no remains of living things. We must not assume, however, because we have so far found no traces of life—and there are some who claim that such traces have been discovered—that there were then no living things upon the earth. We have only a few pages, badly crumpled, scorched, and burnt, of the last two volumes of this series, and there is little likelihood that these should contain evidence of contemporary life. When the next series opens we find life abundant, and consisting by no means entirely of very lowly forms, so that we must postulate the presence of life during the formation of the later volumes, at least, of the Azoic series; for this reason these later volumes are sometimes called the Eozoic Era, or the era of the dawn of life.

The second series consists of three volumes, the first of which, a very large one, is divided into two well-marked parts, each of which is longer than the subsequent volumes, while the third volume, according to the most generally accepted modern view, is not yet complete.

The first volume is called the Palaeozoic Era, or the era of ancient life; it is sometimes known as the Primary Era. The two parts are known respectively as the Lower and Upper Palaeozoic. During the Lower Palaeozoic Era, represented by the Cambrian, Ordovician, and Silurian systems, the higher groups of animals are absent and we have little evidence of plant life. The humbler types of animals are well represented; sponges, corals, sea-urchins, and molluscs are abundant, and the dominant form is the trilobite, a relative of the most old-fashioned members of the group of the Crustaceans, which includes wood-lice, lobsters, and shrimps. Just at the close of the period, in the Ludlow series of beds, we find the first evidence of vertebrate animals in the form of certain types of primitive fish.

During the Upper Palaeozoic Era, represented by the

Devonian and Old Red Sandstone, the Carboniferous and the Permian systems, we note an advance in the complexity of life. All the lower groups are still represented, though the trilobites are on the decline, and disappear entirely before the close of the Permian system. Fish are commoner and more representative of their class as we know it in our modern world, amphibians are characteristic of the Carboniferous, and some of their ancient forms survive into the Permian, while reptiles begin to appear just before the close of the era. Evidence of plant life, especially of ferns, club-mosses, and horsetails, is abundant, especially in Carboniferous times; and, though our modern seed plants, flowering plants, and pines, do not yet occur, the records of the rocks of the Upper Palaeozoic Era are of the greatest interest to botanists who seek to understand the evolution of the seed as a method of propagation.

The second volume of the second series is called the Mesozoic Era, the era of medium life, or better if less accurately, the middle era of life; it is sometimes called the Secondary Era. It is usually divided into three chapters, represented in the Triassic, the Jurassic, and the Cretaceous systems of rocks. This era is essentially the age of reptiles, which were numerous and varied, terrestrial, marine, and aerial; they often attained great size and were heavily coated with defensive armour, especially towards the end of their history. To this class belonged the Dinosaur, which with its eggs was recently found in Mongolia, in a rock belonging to the closing phase of this era. Birds first appear in the Jurassic system, while traces of lowly mammals have been found from the Trias onwards; modern flowering plants are first found about the close of the Cretaceous system.

According to most modern authorities the third volume, the Cainozoic Era, or the era of recent life, is not yet finished.

As far as it has gone, it may be considered as consisting of six chapters, the Eocene, or dawn of recent life, the Oligocene, with a little recent life, the Miocene with more, the Pliocene with much, the Pleistocene with very much, and the Holocene with entirely recent life. The Holocene is more often called the Recent Period.

The Cainozoic Era is essentially the age of mammals, and nearly all the orders of this class appear in the Eocene system, including a lemur, the forerunner of the monkeys and apes. True monkeys make their first appearance, as far as is at present known, in the Oligocene system, and before the end of the Miocene we have at least three genera of apes.

The older geologists separated the Pleistocene, and with it the Holocene or Recent system, from the Cainozoic or Tertiary Era, and called them the Quaternary Era. This was done because it was believed that in this era alone was there evidence of the existence of man. But apart from the reasons already given for including these systems in the Cainozoic Era, it seems probable, in fact almost certain, that man of some kind was in existence in Pliocene times, and, as we shall see later, a claim has been made that a tool-fashioning animal, to which according to our present definition we must accord the courtesy title of man, existed at a period which is claimed by some to belong to the close of the Miocene period. The question, however, of man's place in the geological record must be left to a later chapter.

The distribution of land and water over the surface of the earth has varied considerably during the time covered by the geological record. Continents have come and gone or have broken and drifted, and ocean depths have been opened, though there are certain large areas of the earth's surface which seem to have been either land or water throughout.

ERA	SYSTEM	PERIOD	Some British Beds
CAINOZOIC OR TERTIARY ERA		Holocene Pleistocene Pliocene Miocene Oligocene Eocene	Alluvium Boulder Clays Lenham beds and Coralline Cg. Headon & Bembridge beds. Reading, London and Bagshot beds
MESOZOIC OR SECONDARY ERA	CRETACEOUS	Upper Cretaceous Lower Cretaceous	Chalks & Upper Greensand Lower Greensand and Wealden
	JURASSIC	Upper Jurassic Middle Jurassic Lower Jurassic	Oolites Lias
	TRIASSIC	Keuper Muschelkalk Bunter	New Red Sandstone
UPPER PALAEOZOIC ERA	PERMIAN	Permian	Magnesian Limestone & Red Marls
	CARBONIFEROUS	Upper Carboniferous Middle Carboniferous Lower Carboniferous	Coal Measures Millstone Grit Carboniferous Limestone
	DEVONIAN	Upper Devonian Middle Devonian Lower Devonian	Old Red Sandstone
LOWER PALAEOZOIC ERA	SILURIAN	Upper Silurian Middle Silurian Lower Silurian	Ludlow beds Wenlock beds Llandovery beds
	ORDOVICIAN	Upper Ordovician Middle Ordovician Lower Ordovician	Bala series Llandeilo flags Arenig series
	CAMBRIAN	Upper Cambrian Middle Cambrian Lower Cambrian	Tremados & Lingula beds Menerian beds Harlech series
AZOIC ERA	ARCHAEAN SYSTEMS		Malvern, Longmynd, Scottish Highlands and Donegal

Fig. 2. The Geological Record.

Note. The chart reads, in order of time, from the bottom upwards.

Of the Azoic period we can as yet know nothing, for the only parts of the record found so far are a few scattered leaves, mostly too much crumpled to tell us anything. But from the Cambrian period onwards it has been possible to reconstruct outline maps of the world, which give some idea of the relative positions of oceans and continents. These maps are necessarily tentative and sometimes diagrammatic, and do not profess to delineate the coast-lines with precision. They differ considerably among themselves, and yet certain broad features are common to them all, and may be taken as substantially true.

The records of the rocks have already yielded us an outline of the story of our earth for a long period, a period which must be reckoned, in all probability, at something very considerably over one hundred millions of years; the last million years of this period include the greater part, if not the whole, of the story of man. The progress of research is making ever clearer that during the greater part of this long time the area covered by the northern hemisphere of the Old World has played the major role in connexion with the changes of land and sea, as well as with the rise and decline of mountain systems and with the evolution of life. A great number of observations have been made and inferences have been drawn from the results of these, and science is beginning to see that there is an orderly sequence in the events of the earth's history.

It was suggested long ago by O. Fisher that, at a certain depth in the earth's crust, the temperature was so high that only the tremendous pressure kept matter solid, and that local changes would cause it to melt and expand, thus bringing about movements of the earth's crust. Others have suggested that this intensely hot mass may have been subject to tidal influences, and that these may have been important in the earlier phases of the earth's story. Joly has added the idea that this same mass, which is now generally supposed to be rich in heavy metals and to be allied to basalt, contains radioactive minerals, that is to say, minerals that decompose very slowly of themselves, for they seem to do so independently of outside conditions. As they decompose, these minerals give off heat, which is unable to get away since the magma, as the all but molten layer was called, is so compressed. This heat, therefore, accumulates within the magma until a crisis supervenes, when there is more than enough heat to melt it even at the high pressures prevailing. The molten magma has a larger volume than the solid, as we know from experiments with basalt, which suggest a 10 per cent. difference. This expansion carries, as a consequence, a decrease of density, so that the solid crust, resting on magma which has become fluid, may well tend to sink into the magma. This would give a phase, known as Oceanic Transgression over the land, during which areas of land are submerged. The magma, cooled by its expansion and its changes of position, solidifies again, and in doing so, becomes more dense, so that the solid continents become buoyed up and the oceans recede, causing land to emerge. These are a few of the fertile suggestions made by Joly, and, among their many points of interest, we may note the alternation of phases of submergence and re-emergence of land.

Related to the ideas of Joly and of Fisher are those of Argand, Kober, and Wegener, who look upon the continents as crustal fragments, collectively termed Sial, floating in a very dense magma, termed Sima. The Sial, in their view, never covered more than a portion of the earth's surface.[1] They think that

[1] It is named from the chemists' abbreviations Si and Al for silicon and aluminium, its two chief constituents.

various crises have led to the splitting of the Sial, and that its fragments have wandered off in many directions. Their wanderings have led to crumplings and tiltings, especially of their edges. Joly has a somewhat different idea. He thinks that, when magma which has been melted has become solid again, it contracts, and the crust above it thus tends to crumple, especially at the edges, giving rise to foldings near, or off, the shores of ancient lands. Both draw attention to the folding which has taken place in the coastal zones of ancient lands.

The Swiss geologists, Argand, Staub, and Collet, have ideas somewhat akin to those of Wegener, in so far as his are akin to those of Fisher and of Joly. In their view the Alps were built up owing to a huge northward drift of the African land-mass through several degrees of latitude. Prior to this event there had been a deep sea, Tethys, between the ancient block of North Europe and the ancient block of Africa. The northward advancing edge of Africa was forced to override some of the southern portions or extensions of the ancient block of North Europe, and tremendous folds laid themselves out one over another, as is shown in the new Alpine map by Staub. The movement of Africa northwards is said to be a part of a general breaking up of the ancient southern continent known to science as Gondwanaland. Other pieces of Gondwanaland are Madagascar, the Deccan, the West Australian plateau, and East Brazil, and the view is often taken that they were joined to Antarctica. All these modern theories must, no doubt, be sifted a great deal before any degree of assurance is reached, but they indicate important lines of thought, along which the movements of the earth's crust are now being worked out. They permit us to give the following as a tentative historical sketch.

It is generally agreed that, during the period immediately

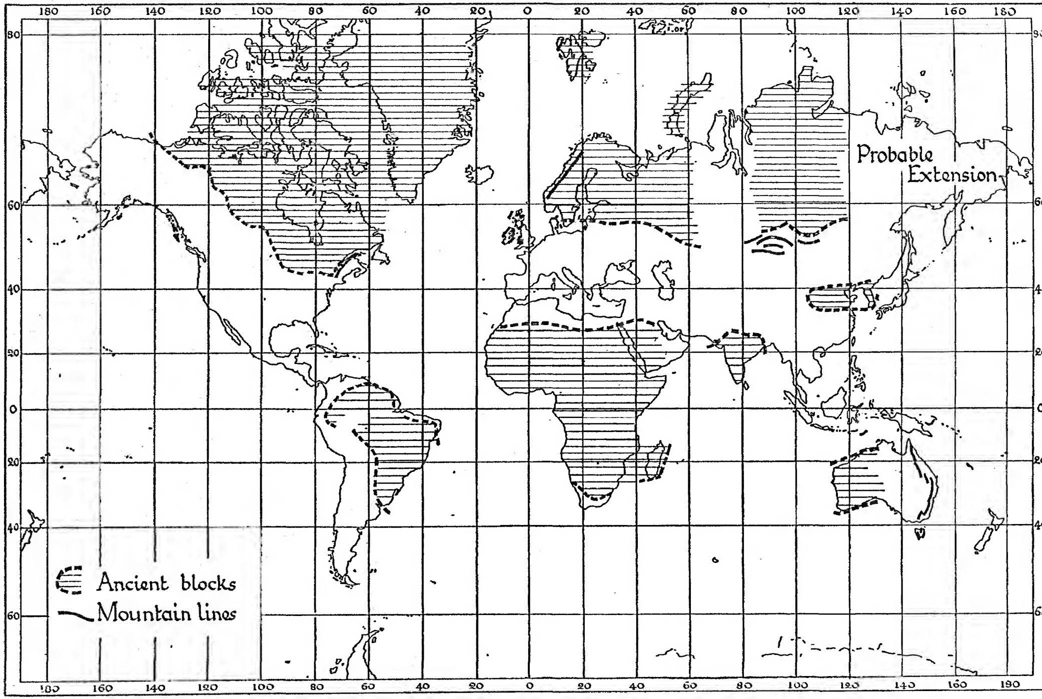

FIG. 3. Map showing the mountains of the Caledonian system.

preceding the Palaeozoic Age, mountain building was taking place (see Chart, p. 27), for almost all the masses of Archaean rocks which have been studied show complex foldings. The fact that over large areas these folded Archaean rocks are covered by non-folded deposits of Lower Palaeozoic Age, goes to show that this mountain building was followed by a long period when the rocks were exposed to wearing away or denudation, with the spreading of the sea over the land, even over some part of the framework belt around the Arctic Ocean, especially in North Europe.

At the close of this cycle occurred another phase of mountain building, which we call the Caledonian (see Chart, p. 27), because it was specially studied by Lapworth in the Highlands and Southern Uplands of Scotland; this mountain building may also be traced in the Scandinavian Uplands, in Canada south of the St. Lawrence River, and in North Asia in the region surrounding Lake Baikal, as well as in the dividing range of Eastern Australia, according to several geologists. That a great mountain building process of this kind did not occur everywhere at quite the same period is highly probable.

We may thus picture a period when a considerable area of mountainous country shut off the Arctic Ocean and its surrounding belt from the middle or temperate latitudes of the northern hemisphere. According to Ellsworth Huntington and C. E. P. Brooks, this shutting off of the Arctic Ocean and of its cold currents would result in the raising of the temperature of the lands south of the mountains; we seem to have abundant evidence of this in the giant forests of the Carboniferous period, which resulted in large deposits of Coal Measures, such as those in Britain and mid-Europe, as well as some in North America. These seem to have been formed when the period of oceanic transgression which followed the

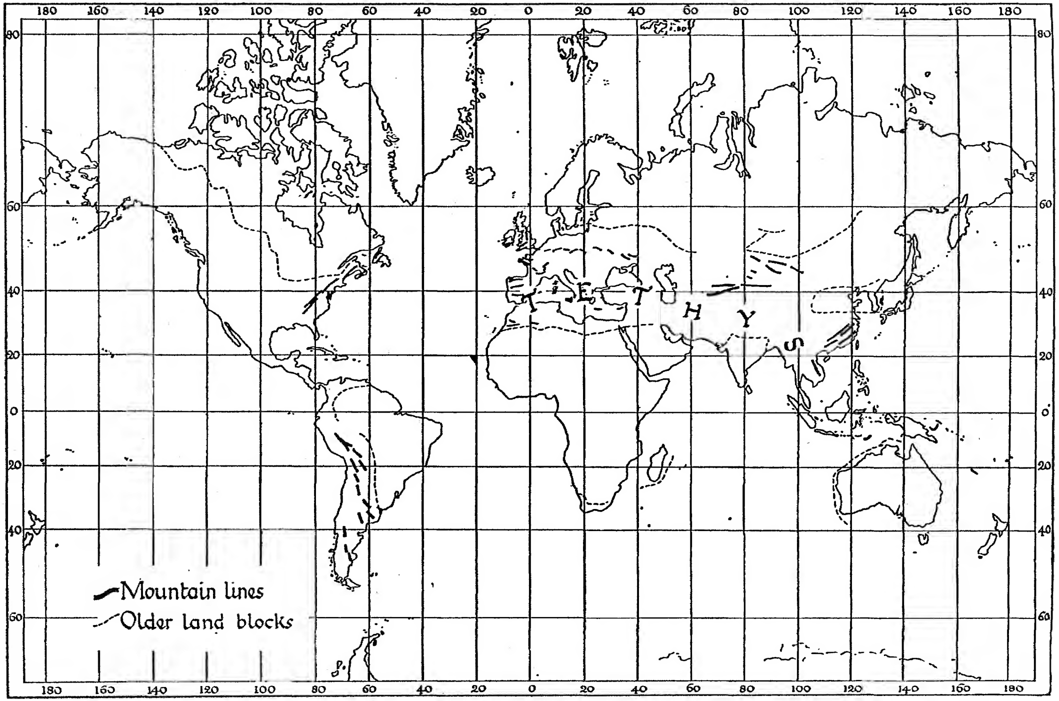

FIG. 4. Map showing the mountains of the Armorican-Hercynian system

Caledonian mountain building, was passing away and the next phase of mountain building was about to begin. One should, however, note Wegener's view that the coal forests of Eurasia, North America, &c., formed a fairly continuous belt before America drifted away from the Old World. He also thinks that they represent the equatorial belt of their day, for it is part of his theory that the poles have shifted.

The new phase of mountain building after the formation of the Coal Measures is variously known as the Armorican, Hercynian, Variscan, or Appalachian (see Chart, p. 27). We have abundant evidence of it in the Old World, stretching from the Spanish plateau eastwards north of the Alps, the Armenian mountains, and the Pamirs, in the direction of Korea. In the New World the High Land on the eastern side of North America belongs partly to this and partly to the former system.

This period of great crust movements, accompanied by the formation of large and high land-masses, resulted in a general cooling of the climate; this cooling was much more marked in some areas, and culminated with the growth of great sheets of inland ice. Such a crisis in the northern land-mass involved large changes in plant and animal life, in the sea as well as on land, and it is this crisis that marks the end of the period of ancient life, i. e. of the Palaeozoic Age of the palaeontologists. Several groups of marine animals of earlier times either vanished completely or preserved only a very few survivors; several groups of old-fashioned land plants also disappeared. Seed-bearing plants, however, and backboned animals, with eggs either rich in yolk and protected by shells or preserved within the mother's body, survived. These, the reptiles and the progenitors of birds and mammals, herald their advance as the successors and replacers on land of the old amphibians of the coal forests. Their special features include, as has just been seen, improved arrangements for the protection of the young during development under land conditions.

Following this crisis in the history of life comes the period of quiescence with the mountains wearing down, the climate growing milder and the seas spreading over the lower lands, especially in the middle latitudes of the northern hemisphere to the south of the mountain lines. To the great sea of these latitudes, covering what is now a belt of land across Eurasia, the name of Tethys has been given, and Myres has recently given a short summary of the views which have been expressed about it. The plants of middle latitudes at this time indicate a warm climate with plenty of moisture, while coral reefs, again indicating warm conditions, are of common occurrence, as for instance in the Jurassic rocks of Western Europe.

The extensions or 'transgressions' of the seas reached their maximum in the Cretaceous period, when the chalk was being laid down over a large region, and it would seem that their great expanse limited the range of many plants and their attendant animals, such as the great reptiles and ancient birds. Plant life seems also to have changed in character through the rapid spreading of grasses; while, among land animals, we have a remarkable development of what had been lowly forms, feeding on low vegetation, and developing their young within the mother's body.

This oceanic transgression was followed, as before, by a mountain building period, the Alpine-Himalayan (see Chart, p. 27), which, in this case, can be followed in more detail. It did not occur everywhere at once, but it spread in time along many parts of the southern edge of the old subarctic belt, now much widened by the addition to its surface of the remnants of the older mountain-chains; this, at least, is a fair description of its spread in the Old World. The position of the new chain in Europe and Asia and its relation to other geographical features, accord well with the idea that it is due largely to a northward drift of fragments of Gondwanaland, and, in this connexion, we may note the immense hollow of the Southern Ocean south of Africa and Australia as, in a sense, the complement of the mountain building in the corresponding longitudes farther north. Accompanying this immense crumpling there must have been innumerable other strains and fractures, among which the great rifts of the Jordan Valley, the Gulf of Akaba, the Red Sea, and the various rifts in East Africa are usually reckoned.

The western side of the New World along its whole length from north to south also witnessed great mountain building during the same phases of the earth's history. The folds there are crumplings of the earth's surface pushed eastwards in varying degrees in different parts. When, as in the north, the older land blocks on the east were very extensive, the folds are concentrated near the Pacific. On the other hand, when, as in Central America and south of Patagonia, the older land blocks were small, the folds bulge eastwards in great curves in the West Indies and in the islands between South America and the Antarctic. On Wegener's view the older land blocks of eastern America have drifted westwards, leaving behind them the great hollows of the Atlantic. In their westward drift towards the Pacific huge crumplings of the Pacific edge have occurred, and these upward crumplings have laid themselves down eastwards, that is towards the advancing land blocks. The folding was not all of one age, or all in one system. One main subdivision seems to have run from north-east Asia round to New Mexico, while another runs from Cape

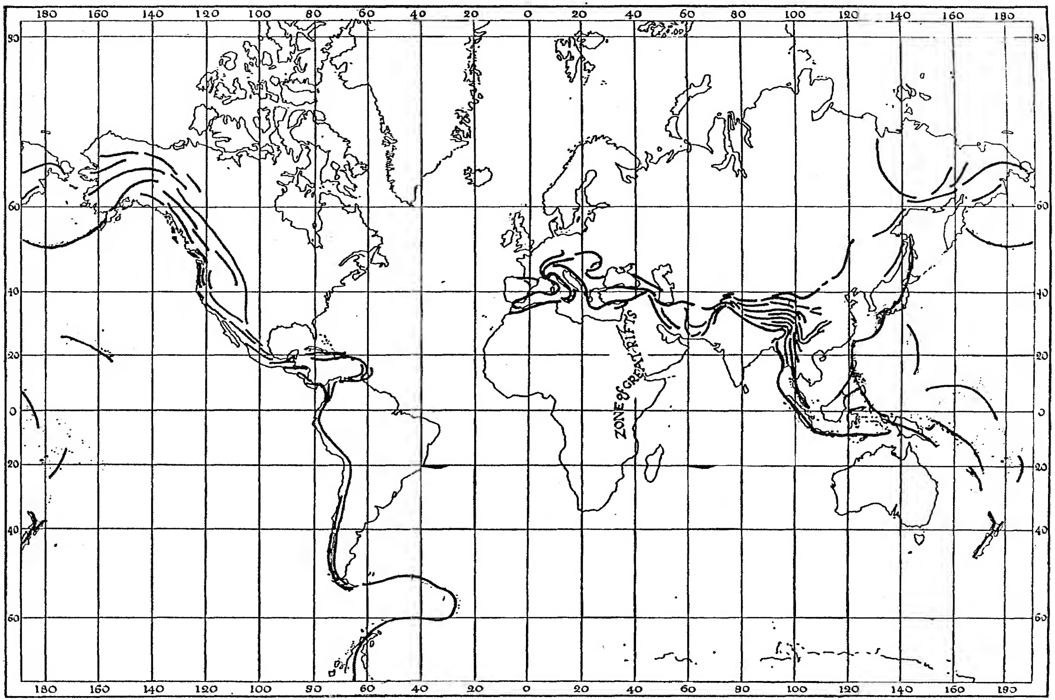

FIG. 5. Map showing the mountains of the Alpine system and the rift valleys.

Mendocino on the Pacific coast of California southward to the Antarctic. An older element of the latter subdivision is the eastern Cordillera in the middle region of South America.

The strains involved in mountain building at each phase seem to have led to the tilting up, with much fracturing, of what remained of the bases of the older mountain masses. Many of the world's most important ores of copper, tin, lead, silver, gold, &c., occur in veins in the minor fractures of these older masses, a fact of the utmost importance in connexion with the story of man in the early ages of metal. Classic examples are the plateau of Spain, so important in the early story of metal in Europe and the above-mentioned eastern Cordillera (the highland of Bolivia), which bore the same relation to the ancient civilizations of Peru.

The phase discussed above, like at least one of the earlier mountain-building phases, was followed by a period of cold and the development of ice sheets; the increase of cold is abundantly evidenced in the deposits of the close of the Pliocene period in the northern hemisphere. We thus come to the Ice Age, sometimes called the Quaternary Ice Age, the latest of an apparent series of ice ages in the earth's history. This Ice Age, with which we shall deal more fully in a later chapter, and its various phases, are being co-ordinated in ever-increasing detail with the story of early man.

We may here note that with the last phase of the Caledonian mountain-building period we have the deposits of the Old Red Sandstone, indicating dry and desert-like conditions. Again, after the Permo-Carboniferous glaciation (see Chart, p. 27) we have the deposition of the Keuper and Bunter sandstones in the Triassic period, representing a similar dry period. Lastly, after the last Ice Age, and perhaps, too, during its latest phases, we see the gradual drying up of the

CAINOZOIC OR TERTIARY ERA	Holocene Pleistocene Pliocene Miocene Oligocene Eocene	Desert Glaciation Alpine-Himalayan Mountain-building
MESOZOIC OR SECONDARY ERA	CRETACEOUS JURASSIC TRIASSIC	Oceanic transgression Desert
UPPER PALAEOZOIC ERA	PERMIAN CARBONIFEROUS DEVONIAN	Glaciation Armorican Mountain-building Oceanic transgression Desert Glaciation Caledonian
LOWER PALAEOZOIC ERA	SILURIAN ORDOVICIAN CAMBRIAN	Mountain-building Oceanic transgression
AZOIC ERA	ARCHAEAN SYSTEMS	Desert Glaciation Mountain-building

Fig. 6. Tentative chart of the periods of Mountain-building.

Note. The chart reads, in order of time, from the bottom upwards.

belt, which is now desert, stretching from the Sahara to the Gobi. All of these features are specially developed in the northern hemisphere of the Old World.

This last phase of mountain building (the Alpine-Himalayan) cut off to some extent the tropical forest lands from the more northern plains, and may very probably have increased the amount of open and unwooded country. This is a fact of the utmost importance when we think of man, adapted to live on the ground as well as in trees, ready for either emergency, *in utrumque paratus*. The rich vegetation of earlier times begins to diminish, and much of it is, as it were, squeezed out between the ice sheets on the northern lands, such as Scandinavia, and those on the newer mountains of the Alpine-Himalayan system on the south.

In the Americas, on the other hand, the mountain building ran on north and south lines, and this allowed the vegetation to retreat southwards as the north became colder, and to return northwards once more after the Ice Age had passed. Thus the 'big trees' of California seem to represent a type of vegetation that dallied in a goodly and pleasant land on this northward journey, and under favourable circumstances grew to a prodigious size.

We note, in conclusion, that at three of the crises in the history of life, the land animals that survived were those which made the best provision for the next generation. It also follows from our story that northern lands, and especially Eurasia,[1] are regions of crisis. The southern lands have had different crises, with at any rate far less mountain building, and they have remained in many ways refuges of old-fashioned things. This is true of man and his societies, of plants and animals, and even in a measure of land surfaces. The crises of

[1] A convenient term for the Continents of Europe and Asia together.

the north, on the other hand, have made that part of the world a home of change, a centre of evolution, a birthplace of the new.

In the Old World, before and during the last Ice Age, several mammals became extinct, or restricted their range to southern lands; with the readvance of the temperate forest in Europe, as the climate improved, most of them finally disappeared. One mammal, which spent more energy than the others on the care of its young, and which had developed specially increased sex differentiation for this purpose, came through the cold period and the Ice Age which followed it with enhanced possibilities; that mammal was Man.

It should be noted that the discussion of Joly's ideas is proceeding apace and the present tendency (1926) is towards recognition of a comparatively large number of phases of mountain-building affecting diverse regions, in place of a few phases of general mountain-building. There is also a tendency to reduce the chronological estimates of the periods involved. We have thought it best to omit discussion of these complexities.

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3

A Glimpse of the Evolutionary Process

Variations and their accumulation

only with the work of Lamarck, Darwin, and Wallace that science in the nineteenth century began to gain real insight into the processes at work transforming living things in the course of ages. The thoughts of these great pioneers have been sifted again and again by their successors, and the fact that some processes have been at work, which have effected great transformations in plants and animals, stands demonstrated beyond all cavil, but the processes themselves are still the subject of great differences of opinion.

Lamarck, a generation before Darwin, aroused much opposition by his suggestion that characteristics acquired during the life of the parent, for instance by the use or disuse of certain organs, can be transmitted to the offspring. The blacksmith's children would not, in all probability, have extra strong arms if they were brought up delicately and kept away from their father's forge. But the facts are often more complex than that; a man may have his arm amputated in youth, and this may affect the nervous system. If it were possible to imagine the same mutilation generation after generation for a long time, one would not be over ready to say that no heritable results would follow. Moreover, the body may influence the germ of the next generation in endless subtle ways.

There are two main views. One that some feature *acquired by the individual in the course of its life* is passed on to its descendants; the other that the feature supposed to have been acquired *really depends for its existence on something in* *the germ* whence that individual arose. Modern research and speculation have made the problem so complex that in some controversies the two sides have merely supported different interpretations of the known facts; neither of the interpretations could be verified. Weismann, in particular, did a great deal to destroy easy confidence in the inheritance of acquired characters; he helped to build up the idea that the germs for the next generation are set apart within the body at an early stage in the individual's development, and that there is an approach to continuity of germ-tissue from generation to generation. Thus the germ, in his opinion, would not be subject to changes that were adaptations to outside circumstances. Weismann denied the inheritance of acquired characters, and so ruled out altogether the Lamarckian view.

Darwin's and Wallace's famous work established the occurrence of evolution and the unity of man with animate nature in general. They were deeply impressed by the fact that no two individuals are ever exactly alike, and they both thought this variation offered a basis for evolution, inasmuch as some variants would be more viable and some less.[1] The more viable forms were conceived of as passing on their superior qualities to their descendants, and it was supposed that a great deal of evolution had come to pass by the accumulation of inheritances of such changes. This process, involving the survival of the more viable and the elimination of the less viable, was called by its sponsors, 'Natural selection', and some of Darwin's successors were apt to exalt it into the supreme, perhaps the sole, cause of evolution.

Darwin and Wallace realized that neither of the origin of variations nor of their inheritance do we know very much,

[1] Viable, a term meaning 'capable of maintaining its life or the life of its kind', is used here in preference to the much controverted word 'fit'.

and great efforts have been made to show that many of the minuter variations, which constitute the differences between individuals of the same species, are not heritable. If that view were established, the importance that Darwin attached to the universal small divergences between individuals might be found to have been too great.

The following work has been held to demonstrate effects of the natural selection of small variations. Welldon observed that in muddy water the broader-backed members of a certain crab population became less viable. They were eliminated as a result of respiratory trouble; the broad shell meant broad gill-chambers, and it was difficult to keep these clean-swept. This is claimed as one of the relatively few cases in which natural selection has been observed actually to change a type while under observation.

This view of natural selection *as a factor of change* is widely supported, but also widely controverted. It must be distinguished from the idea of natural selection *as a standardizer* through the elimination of the less viable.

It is to be remembered here, as J. Arthur Thomson and Kropotkin have so variously pointed out, that there has been for millions of years a web of life, as Thomson has well called it, with the myriad species of animals and plants taking various places in that web, and probably as often contributing one to another as they compete with one another. One plant grows in another's shade, and flowers and insects have their well-known bonds, but these are only the more easily perceptible of mutual relations and influences that spread in countless ways through the world of life.

De Vries showed that many large variations, called mutations, are heritable. This he showed chiefly by studying the Evening Primrose, and he believes that exposure to a new environment is a probable cause of mutation. Mendel, though his work dealt with inheritance rather than evolution, supplied an important clue to what may be called Mutational Evolution, for he showed that characters were often inherited whole, even if possessed by one parent only, so that intercrossing need not swamp a new variation, even if it occurred in only a small proportion of a population. While it is impossible to demonstrate the same principle when we are dealing with smaller variations which can be detected only by measurement, there is no *a priori* argument against the same principle working as much in the case of small variations or as in those of large variations and sports.

Gulick and Romanes both, in different ways, laid stress on the possibility that, in different geographical areas, the variations in an organism follow different lines and thus accumulate differences. They both took it for granted that variation is universal, and pointed out that, if the same animal or plant inhabited two areas quite separate from one another, the variations could not possibly be just the same in the two areas; thus, in the course of time each area would have its own race and after a long interval the accumulation of differences might be great enough to make the two into distinct species. Gulick claimed to approach a demonstration of this by a minute study of the land snails of the Sandwich Isles. It has not been sufficiently recognized that there are many types of isolation besides geographical isolation of that kind. If the life-processes slow down a little in some flowering plants, for example, they may bloom later than their fellows, and so be isolated from possible intercrossing; thus separate races and ultimately separate species might arise. Differences of religion are well-known barriers to intermarriage in Ireland and elsewhere.

Students of fossils are able to trace changes of forms of life through almost imperceptible gradations, and they have discussed the idea of Orthogenesis, or, emphasizing the internal factors in the process of development, Hologenesis. Beecher and other palaeontologists have suggested that the history of a group often starts with humble and rather unadorned types, that, with increase of numbers and types, some large ones come into existence, that these often become complex and may gain adornments, and that the exaggeration of these adornments in the end leads to sharp ridges or projections and great peculiarity of form. In other words, a great deal of evolution has probably occurred by some process of accumulation of variations, which often enough cannot be imagined to be adaptations, so that the strict Darwinian idea is not invoked here, though probably non-viable variants have been eliminated *en route*.

Some factors of change

Concerning the causes of variations we as yet know little enough, though the idea of the sensitiveness of the growing organism is helpful here in ways that have not as yet been fully grasped; the idea that changes of circumstances affect the sensitive growing organisms as they range beyond their first home is also important.

Standfuss in Zürich reared tortoise-shell butterflies under unusually cold and unusually warm conditions, and the insects resulting were in the former case like those from North Europe, and in the latter like those from Mediterranean lands. This suggests that what have been described as three varieties, found one in warm, one in medium, and one in cold regions, are merely the result of diverse environments working upon the same inheritance. The Central European variety might thus give birth to individuals which could be so developed as to resemble the northern variety or the southern variety, and we may thus have a picture of what happened with the spread of a species. Willis developed this line of thought and argued that old types are generally found widely distributed, with many modifications of those types in special areas of distribu-

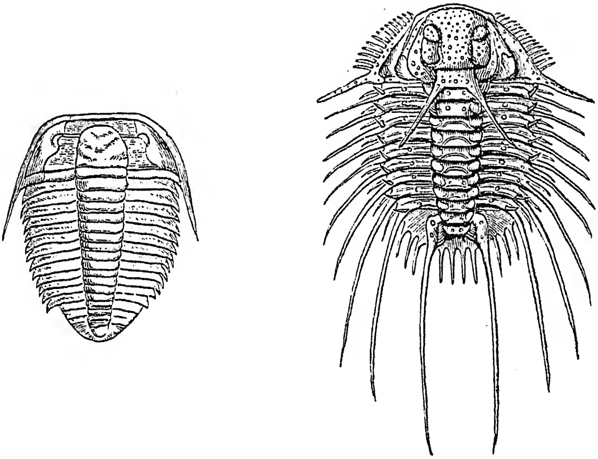

Fig. 7. Simple and adorned trilobites.

tion. The general principle would thus be that the spread of a species in space would bring its members into a diversity of environments, which would lead to modifications of the individuals as they developed; and the permanence of the various environments, each peculiar to its special locality, would make for the permanence of the changes due to them. How far the germ itself is changed is quite uncertain, but if it were found that results of a change of environment were ultimately made heritable, then germ-change would be supposed by many biologists to be involved.

P. Geddes and J. Arthur Thomson have presented some interesting considerations of general biology. The many chemical changes going on within a living body may be classed as either Anabolic, building up substance and absorbing energy, or Katabolic, breaking down substance and setting energy free. The katabolic and anabolic tendencies within the body are ever in competition, with results that vary from time to time in the same individual, from sex to sex in individuals of the same type, and so on. Geddes and Thomson see the two processes working in a roughly average ratio one to the other for each sex of a particular type in a particular environment, and there seem endless possibilities of change in the living body following upon alteration of this ratio, which obviously is very easily affected.

Modern physiological research on the internal secretions of the thyroid and other endocrine or ductless glands, which are so important a feature of the bodies of at least the higher animals, has suggested that we have here other causes of changes in the growth and activities of organisms. It still remains to be investigated whether, as seems probable, there are analogous influences working through the lower animals and plants.

A summary

Summarizing the position thus far, we may say that in the first place the fact of change of forms of life under the influence of processes is demonstrated beyond controversy, but the processes themselves are difficult to elucidate. It becomes ever clearer that the organism responds in some way to its environment, and that these responses accumulate in successive generations and so lead to the great changes that are familiar to every student who has caught a glimpse of the pageant of life through the ages of the past. Progress of thought has for years been tending towards a fuller appreciation of the sensitiveness of the organism in its growth and activities to the circumstances under which it has to live, but we must carefully avoid a too crude determinism which might see the changes in the organism as the inevitable results of outside influences.

It must be remembered that the environment only presents to the organism opportunities or difficulties; the organism may cope with the situation in many different ways. It may respond to a favouring change of environment by increase of length of life; this increased length of life may in the case of mammals include a lengthening of the period before birth. Or it may respond by increased rapidity of growth, without increase of size, or by production of an increased number of offspring, and so on. And each change means consequent changes in the distribution of energy to the various parts of the developing organism; 'the struggle of the parts' is a telling phrase due to Roux.

We may say that variation, as between individuals, is universal, and arises from many causes only dimly understood as yet. It is seen not only in the characters of the adult but in the processes of growth, in the amounts of available energy, in the whole being, not only as a complex structure but also as a working concern. We may further claim general agreement for the Darwinian idea that the less viable forms have usually, in the end, been eliminated. We may also claim a growing recognition, not indeed for the bare Lamarckian idea that effects of use and disuse are directly passed on to descendants as such, but for the subtler idea that the organism, especially during growth, is very sensitive to change, and that the adjustments made in it somehow affect not only their possessor but also his descendants, as the second commandment of the Mosaic code tells us.

Organism and germ

As to how, if at all, the responses of the organism to changes in the environment come to be imprinted in the germ for succeeding generations, we are almost completely in the dark. It is true that, as regards mammals, we know that the body includes a number of what are called endocrine or ductless

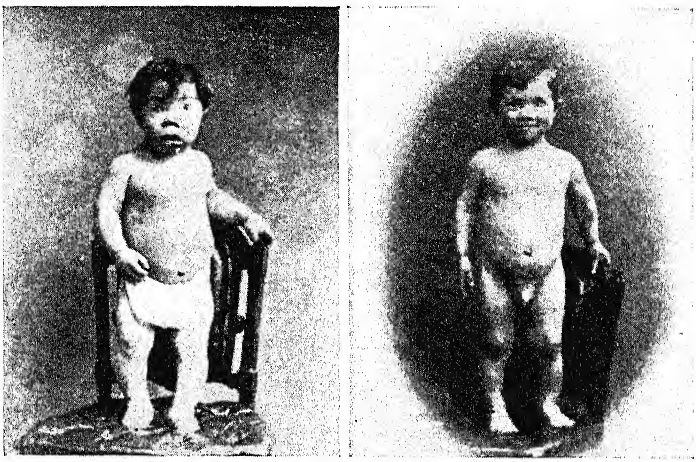

FIG. 8. A patient before and after thyroid treatment.
From the Collection of the Royal College of Surgeons, England.

glands, which extract or secrete particular substances and pour them into the blood. These secretions, such as that of the thyroid gland, stimulate growth in some cases, perhaps hold it in check in others. The secretions affect the circulation and so influence the whole body. The sex organs form some secretions of the kind and seem to be affected, too, by the others. It is quite likely that these secretions may carry influences to the germ, and in this connexion has arisen the notion of hormones, active components of the secretions, circulated to the various parts of the body. Apart from this there is the possibility of influencing the rhythm of activities right through the body, and thus of affecting the germ and its development.

The process of evolution of the mammals has been more rapid than that of some other groups, and it is important to note in this connexion that in this class the scheme of internal secretions seems complex and influential, whereas we know very little of the kind in invertebrate groups. With this goes the increased sensitiveness to change in the whole constitution. With this also goes the increased unity of the organism, a factor which must have tended to give importance to brain growth, since the brain is increasingly, as we proceed from lower to higher organisms, the central organ of control. It is quite possible that future discoveries may help us to find analogous processes of influence of the parts of the body on one another, and, possibly, on the germ in other groups of living things besides the mammals.

Growth and change

Another way of looking at the evolution of living things is possible, and this newer point of view is developing rapidly in the minds of a number of thinkers at the present time. Geologists have accumulated a vast mass of evidence concerning changes of environment extending over immense periods in the past. A cooling of climate in certain latitudes, slowly intensified through many thousands of years, followed by a return, perhaps at a different rate, to warmer conditions, has probably occurred again and again in earth history. Such changes may well influence the rates of the processes of life, the extent of growth, and so on, and, as these changes go on generation after generation, we hardly need to assume the principle that acquired characters can be transmitted in order to understand that the change persists and indeed accumulates. And every such change probably affects different parts of the organism differently, and so alters the balance of development, that is to say their relation to one another as they develop; this may well be the starting-point of many and varied, and at first thought unrelated changes. When we note, as a possession of some animal, some special feature that may be of advantage to it, as for instance the white coat of an arctic mammal, we are apt to think of it as in some mysterious way given to the animal because it is of use. It may be a result of alteration in the balance of development as above suggested, though this in no sense conflicts with the view that, if it made the possessors much more viable, as it presumably did, this may help largely to account for its survival.

If a region is growing cooler, the growth of its organisms under cooler conditions than their parents felt becomes an important fact of life acting generation after generation with, for a time at least, increasing intensity. If we suppose this cooling to exert an influence changing the character of the organism, we see that this influence is repeated generation after generation. In other words, whether or no the change of character of the organism is merely a change of the body or is also a change in the germ, it carries for the next generation, the influence that caused the change originally acts afresh, and in the same way on many succeeding generations, very likely in intensified fashion. Such earth-changes as the cooling of regions occur slowly, and so the influence is repeatedly exerted on, it may well be, thousands of generations, and none escapes it unless there may happen to be a very exceptional season now and again. There is thus an enormous period during which either the hormones above discussed or other influences may gradually attune the germ to the new state of affairs.

Is this attuning a definite process? That we cannot say,

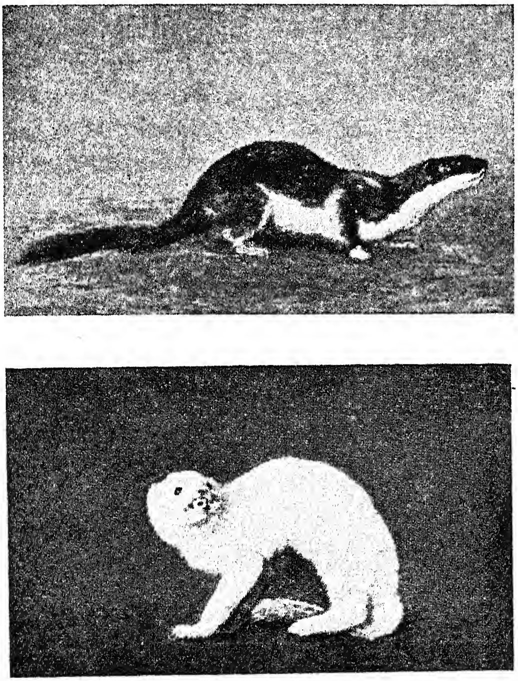

FIG. 9. Stoats in summer and winter coats.

and it would be difficult to imagine. But it seems almost inevitable that individuals in which the germs were more attuned would be more likely to produce viable offspring, and that the more attuned germs would be more likely to survive than the less attuned ones from the same parent.

The sensitiveness of the growth process, at least, is a well established fact, and the repetition of such influences as those of changing climate is also obvious, and the repetition of an influence may secure the repetition of its effect. Its intensification may go farther and cause an intensification of the effect.

Perhaps this way of looking at evolution may help to overcome another difficulty of biologists. The immense changes in organisms have often been supposed to be necessarily the result of accumulated minute changes generation after generation. This may well express the truth for many cases, but it should be remembered that a change, which may be very slight in the young form, may become more important by being intensified as the young develop into the adult; it is, also, a question for the future whether the mutations of De Vries (see p. 32) may not in some cases be of this nature. If the effect of environment is cumulative, and works largely through influence on early stages of growth, the process of evolution may have been more rapid than is often believed, especially if we realize that the influences are not likely to affect all parts of the growing body alike.

Evolution and earth history

Summarizing the ideas of the last section, we may picture the pageant of evolution of living things as the accompaniment of the evolution of the earth's surface. The valleys are exalted and the mountains and hills are laid low and the royal road of change winds on unceasingly. It is no more possible to interpret evolution by making a list of processes which might act at all times than it is to explain the story of a nation in terms of single processes that might act on all nations and at all times. The history of life in general is penetrated through and through by that incalculable complexity which is at once

ERA	PERIOD	APPEARANCE OF BACKBONED ANIMALS	EARTH MOVEMENTS.
CAINOZOIC	Holocene Pleistocene		Glaciation
	Pliocene Miocene		Culmination of Alpine mountain-building phase
	Oligocene Eocene	Spread of Mammals	Re-emergence
MESOZOIC	Upper Cretaceous Lower Cretaceous		Wide-spread sub-mergence
	Upper Jurassic Middle Jurassic Lower Jurassic	First Birds	
	Keuper Muschelkalk Bunter		Desert conditions
UPPER PALAEOZOIC	Upper Permian Lower Permian	First Reptiles	Desert conditions Glaciation Armorican mountain-building
	Upper Carboniferous Lower Carboniferous	Amphibians	Re-emergence Sub-mergence
	Upper Devonian Middle Devonian Lower Devonian		Desert conditions Glaciation ? Caledonian mountain-building
LOWER PALAEOZOIC	Upper Silurian Middle Silurian Lower Silurian	First Primitive Fish	
	Upper Ordovician Middle Ordovician Lower Ordovician		
	Upper Cambrian Middle Cambrian Lower Cambrian		
AZOIC	ARCHAEAN SYSTEMS		

Fig. 10. Table of Geological Periods.

Note. The chart reads, in order of time, from the bottom upwards.

the delight and the despair of the student of a nation's history. A few processes may be discerned, a very few may be of a kind to act at all times, the rest act at one time and not at another. So it becomes increasingly important to bring into the service of the evolutionist the data accumulating through the work of those who are studying the history of the earth's surface and the history of its climates. A few examples must suffice here.

We have seen that a phase of mountain building, the Caledonian, was followed in the northern hemisphere by a fairly wide spread of desert and semi-desert conditions; that then there followed a period of warmth and subsidence, the lower Carboniferous, and re-emergence, the Upper Carboniferous. After the re-emergence came another period of mountain building, the Hercynian, then glaciation and subsequent spread of deserts in the Permian and Triassic periods, followed by increased warmth in the Jurassic, and extensive submergence in the Cretaceous and re-emergence in the Eocene. Then comes still another period of mountain building, the Alpine or Himalayan, with glaciation in the Pleistocene; then the spread of deserts in the Early Holocene with increased warmth.

The study of extinct organisms permits us to attribute the great development of Amphibian vertebrates and of the forest trees of the Coal Measures to the period of re-emergence called Upper Carboniferous, and dimly to perceive important phases of the evolution of fishes in the warm seas about and before that period. It enables us, again, to time the great development ot Reptiles and of Cycad tree-forms in the period, known to geologists as the Jurassic, when the middle latitudes were relatively warm; while in the later period of re-emergence, called the Eocene, we have a great development of mammals and of more modern forms of vegetation. Each of these periods has its characteristic evolution of fish forms as well.

Are not these changes in organisms related to the changes in environment previously sketched? The Amphibians grew large with more favourable conditions, and special forms became more and more pronounced, many of these forms being explainable on what may be called principles of engineering. Later on these specialized forms became less and less viable as conditions changed, so that some disappeared; thus only a remnant of the Amphibia has survived to our day. Then with a renewal of favourable conditions the large Reptiles of many kinds evolved and spread, but perished for the most part in the great subsequent submergence. The next re-emergence of land with conditions still favourable brought forward the Mammals, which also became large and took many forms; these, too, underwent a severe sifting when mountain building and cold supervened, though among them the larger-brained forms were in general the survivors. Some of the large forms have persisted to this day, but several have vanished.

It is therefore permissible to state that, if cumulative changes of environment over a long period prove favourable to organisms, those organisms in some way respond by changes of growth, which may be on many lines, leading to many different forms of the organisms, and often for a while to increase of size. When conditions change still further and become unfavourable, the prosperous and lordly creatures of the previous age seem to be too *set* to change much, and again and again they have died out, leaving the field clear for the rise of some new aristocracy from humble and obscure beginnings. This is probably connected with the fact that the organism is originally adaptable, but that when it becomes highly specialized and grows large, this adaptability is gradually exhausted, not only in the adult, but also even in the young.

In place, therefore, of a picture of evolution as the result of certain universal factors, we are coming to emphasize the thought of the long pageant of life changing with the times, and changing, fundamentally, because the first speck of living protoplasm was endowed with that wonderful instability that we call sensitiveness. It is always burning, yet not consumed. The long succession of organisms represent an infinity of reactions to historical changes in environment, and yet they cannot be written down as the helpless slaves of their environment. They may move or may spread from one environment to another. They may react to the same changes in different ways, and so commit themselves and their descendants in very different directions. And some of the changes may be due to the activity of the organisms themselves, as when corals build up a reef that ultimately tops the waves, or goats attack and reduce a woodland, or beavers dam a stream, or vast herds of hoofed animals impoverish a grassland by exposing soil to the dry winds as they kick the surface with their hoofs.

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4

The Descent of Man

MAN is very clearly a member of the group of Mammals called Primates. These were originally, and for the most part remain, climbing animals, and, as such, have limbs adapted for suspension; the front limb has its base firmly fixed by the growth of a well-formed collar-bone. Each limb in nearly all cases carries five digits, and one of these, the thumb or great toe, as the case may be, can be more or less completely opposed to the others. Flat nails are found more generally than claws in this group. There are certain anatomical features of the brain common to the whole group, though within it there is an enormous range of brain development, which contrasts remarkably with the uniformity in the number of digits, five, the primitive number, being possessed by nearly all.

Among the Primates the Lemurs represent the primitive group and are known as fossils from the Eocene onwards; in the Eocene period they inhabited the northern hemisphere in what are now both New and Old Worlds. The survivors live mainly in Madagascar, which has been so long isolated that many higher forms have not reached it, but a few are found in Africa and in South-east Asia. They have opposable thumbs and great toes, and simple brains of lowly type. Special interest has attached itself to an allied form rather smaller than a squirrel, which is called Tarsius, and which lives in the East Indian Archipelago and the Philippines. Whereas the lemurs have a rather long snout, Tarsius has a short flat face with enormous forward-looking eyes, and a remarkable power of moving its head round, as well as of holding itself more or less erect and of leaping on its hind legs.

Lemurs push the snout forward to seize food, but Tarsius seizes it with its hands and uses them to take it up to its mouth. The hair on the front part of the head is directed forwards as in man, and in this and other details of hair arrangement Tarsius stands apart from the lemurs in general. With the immense forward-looking eyes and the flattened face goes the marked shortening of the jaws and the wide separation of the nostrils, which face sideways away from one another. The external part of the ear tube is surrounded by bone, and in this respect again Tarsius is nearer to the higher apes. It will be seen that in some ways Tarsius may not be very far removed from the Lemuroid stock which gave rise to the higher Primates and especially to Man. But many of its features may be specializations of its own.

The higher Primates, including monkeys, apes and man, have been given the name of Anthropoids, and they are usually divided into two sets, the flat-nosed, Platyrrhine, forms of the New World, and the narrower nosed, Catarrhine, forms of the Old World. It has been considered that the Platyrrhines have descended from Lemurs in a line of descent distinct from Catarrhines; they are New World forms and this is the easiest hypothesis. It has, however, been urged at times that Platyrrhines and Catarrhines have too many features in common to make it possible to consider them as descended by distinct lines from a lemur-like ancestor. The Platyrrhines or New World forms are obviously not closely connected with the descent of man, and we may omit further discussion here as to their origins.

The kinship of Man is with the Old World group, the Catarrhines. They all have an arrangement of teeth similar to that of man, a bony tube supporting the outer part of the ear, nostrils close together, and usually a well-developed brain. The various groups of monkeys among the Catarrhines may be passed by without further reference. The higher apes or Simiidae are man's nearer relatives. Four genera now survive: the Chimpanzee, the Gorilla, the Orang, and the Gibbon.

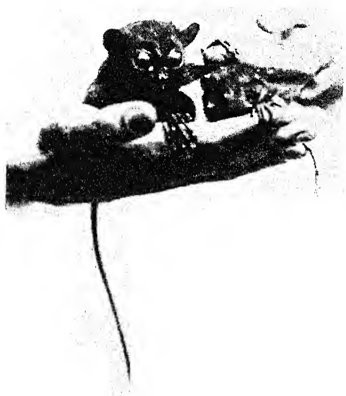

FIG. 11. Tarsius.

The Gibbon is generally allowed to be the farthest from man. It and the Orang are found in the East Indies and both show a high degree of adaptation to tree life.

The Gorilla lives in the woodlands of equatorial Africa and, though it is large and heavy and moves about on the ground, its young are largely tree-living. It seems to have progressed farther towards life on the ground, the human scheme, than any other ape, though the Chimpanzee, also African, can get about more easily than the Gorilla on its hind legs. In many respects the Gorilla and Chimpanzee must have diverged far from the remote ancestor which they shared with mankind. The gap in brain between the Gorilla and Chimpanzee on the one hand and even early man on the other is a striking one, while the development of the muzzle and its muscles and of the ridges on the skull for the attachment of the jaw muscles is most pronounced in the Gorilla and only less so in the Chimpanzee. The skull-ridges and brow-ridges are, naturally, far less marked in the young than in the adults, and generally speaking the resemblance between young apes and humans is much closer than that between the respective adults, a fact which might be drawn into relation with what was said about the process of evolution in the last chapter.

The view is widely held that among fossil Old World apes, Propliopithecus, from the Oligocene deposits in Egypt, is most nearly related to the common stock whence sprang the four types of higher apes and man. Among the higher apes it is believed by some that the Chimpanzee and Gorilla come nearer to man than does the Orang; it is fairly generally allowed that the Gibbon stands somewhat apart, though in the matter of the use of its hind limbs it is probably closest to man. Whatever views are taken as to the interrelationships of man and the higher apes, it is agreed that they cannot have been man's ancestors, but that they rather represent special types that have diverged from man's line of descent and have been distinct from the ancestral stock of mankind since Miocene times.

The eyes look forward in the higher apes and man, and in the latter there is the power of stereoscopic vision, i.e. vision of an object from two slightly different angles, with all that this implies in the way of linkage of the parts of the brain recording visual impressions through the two eyes. It would seem that the power of distinguishing sounds and registering them in the brain attained greater delicacy at an early stage. Both these characteristics are closely linked with the enormous growth of the front part of the brain. Another specialization, intimately related to the foregoing, is the development of the hand and of its opposable thumb, and especially of the right hand, into an instrument of great versatility and delicacy,

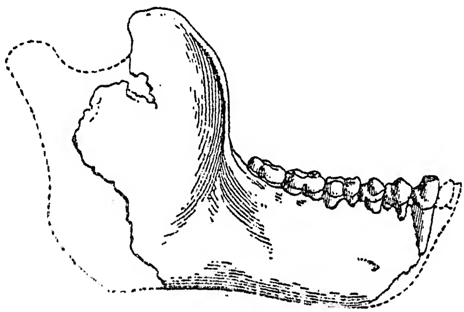

FIG. 12. Propliopithecus.

coupled with the habit of using, and later of shaping, stones for use as implements. Food is thus brought to the mouth by the hands. The hands, especially when armed with flints, can do work previously done by the large and to some extent interlocking canine teeth. These are much smaller in man and do not interlock, so the lower jaw, which in the apes worked up and down and, obliquely, from side to side, becomes freer in its movements. The whole muzzle decreases in size, and correlated with this is the reduction of the ridges of the skull, which in the apes marked off the areas to which the great jaw muscles were attached. As the muscles of the jaw became smaller, the brain appears to have been enabled to grow more freely, a growth that was proceeding apace in correlation with the development of sight, hearing, and manipulation mentioned above. One may think of the saving of energy previously applied to the growth of the muzzle and of its expenditure on the growth of the brain.

It should be mentioned that American anthropologists of late years have devoted much attention to a comparison of the growth and anatomy of man with those of the Gorilla and the Chimpanzee, as well as with the anatomy of such fossil apes as Dryopithecus and Sivapithecus, of the Pliocene and Miocene. An increase of size, and with it probably an increase of the periods of life both before and after birth, may be assumed to have occurred in the common stock whence man and these apes have sprung, and the tendency seems to have continued to develop in man, for the period of gestation in the latter is 280 days as against 220 or less among ancestral apes. This lengthening of the embryonic period has carried with it delay in the hardening of the skull, and so increased growth of the brain, enabling it to register more and more delicately facts of vision and hearing especially. Not only has the pre-natal period been lengthened, but the human baby has become increasingly dependent for a longer time; thus the scope of maternal devotion has increased. This has opened up many possibilities. Hardening of the skull has been further delayed and brain growth has been further prolonged. Opportunities for the educative influence of the mother on the child have increased, and so it has become possible for changes of habit to become established with much greater rapidity. Communication between mother and child has gradually taken the form of modern types of speech through refinement of the ears, probably also through another contemporary change. With life on the ground and forward-looking eyes the tendency has been towards an erect posture, especially as that allowed the

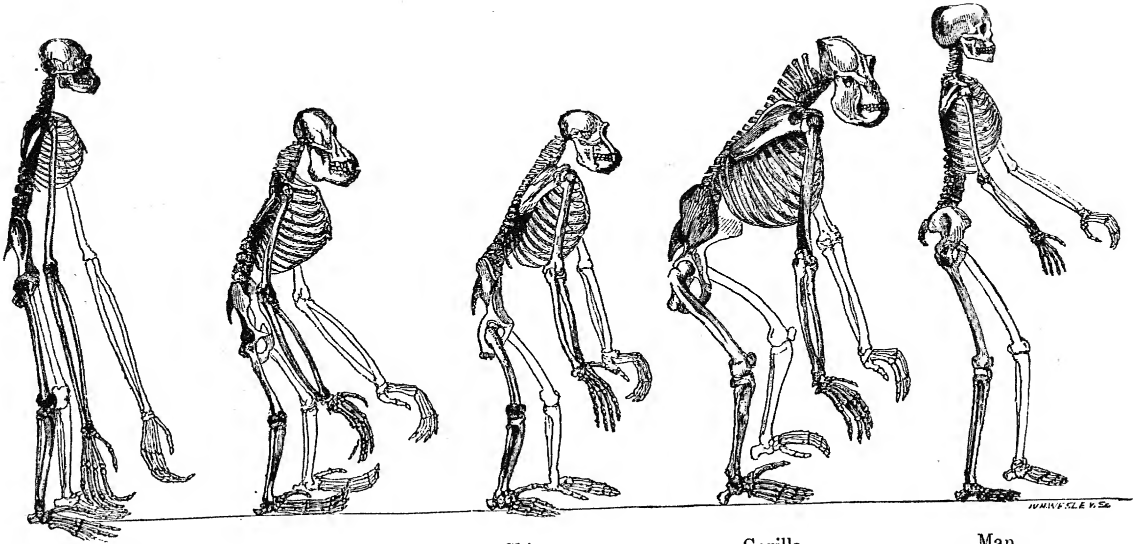

FIG. 13. Skeletons of Apes and Man.

Note: The Gibbon is drawn to a scale double that used for the others.

carrying of the now large and heavy head on the vertebral column; this heralded the shifting of the junction of head and backbone, *foramen magnum*, towards the human position. It also freed the neck muscles on the under side to some extent. It seems that these and other correlated changes in the neck have so affected the larynx as to make speech more possible and more elaborate. That the earliest men were able to speak Elliot Smith judges from a study of casts prepared to show the internal surface of the skull; these reveal several details of the form of the brain. Their speech was, however, rudimentary in comparison with that of modern man, as may be judged both from brain casts and from the way the tongue was attached.

The prolongation of relations between mother and child seems to have carried with it a reduction of the power of the mother to run with the pack. Now, at some early stage in the evolution of mankind, there seems to have come a change in the habits of the quest for food, a change from the gathering of vegetable food as a sole resource to the hunting of flesh as a supplement to vegetarian meals. The hunting of flesh is a habit pursued in our species almost universally by the males, and a reason for this very unusual sex-division of labour in the food quest may well be the facts of prolongation of nursing already mentioned. That man was a social animal ancestrally seems certain, so we have the male or males bringing flesh food to the family or group, the members of which, mother or mothers and children, seek supplements, as the male does too, from berries, roots, and so on. It is difficult to avoid the supposition that the adoption of flesh hunting is connected with a spread of mankind to regions, most likely of grassland, where the vegetable food to be gathered would be less abundant, and where the cooler climate would make animal fat a most valuable part of the diet. At any rate the adoption of this diet helped man to spread over the temperate northerly grasslands, and probably to survive the Ice Age.

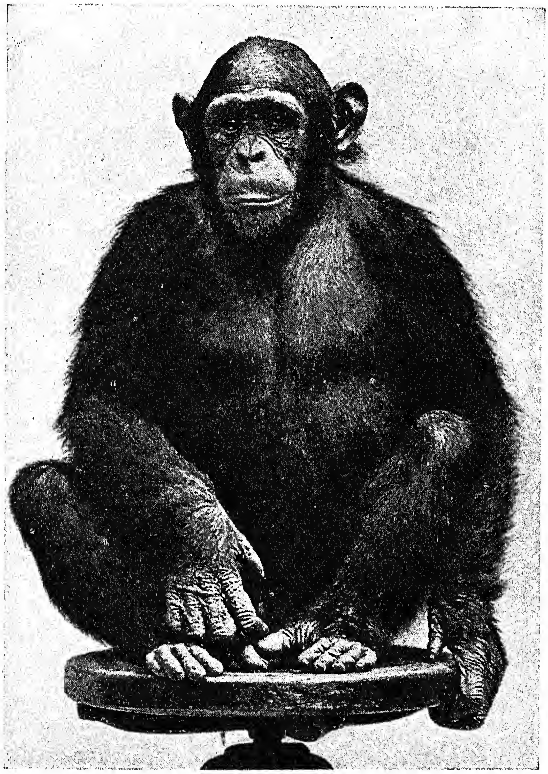

FIG. 14. Chimpanzee.

Into the special question of the Lemuroid stock, whence the great apes and man diverged, we need not enter here, nor do we think it necessary to do more than mention the strange views of a few anthropologists, who hold that some human stocks, ancient and in some cases modern, have descended from apes of one kind or rather from their forbears, and that other human stocks are related to other apes. The resemblances between the various types of man seem too great to justify such ideas, and, moreover, it appears that fertile marriages are possible between members of any two of the various human stocks; if this last fact is really fully established the notion of distinct animal origins for different groups of mankind must surely be given up. We also omit any discussion of the extent to which the Gorilla, Chimpanzee, and other apes have diverged from the remote ancestor they share with man.

The probable place of origin of man has been a subject of much speculation, as has also the period at which we may suppose the human story to have begun. Comparing Mousterian and Aurignacian men as known from their skeletons, we see that they show several types fairly distinct from one another, and we can hardly avoid the view that they represent the result of long courses of evolution from a common human ancestor. The fashioning of the early Palaeolithic, Chellean, flints betokens a high degree of purposeful skill and artistry, and, whatever we may think about the Eoliths, Rostrocarinates and Cantal flints, to be described later, we are bound to assume that man is much older than the period called Chellean. His origin doubtless goes back at least deep into Pliocene times.

This fact makes speculations as to his place of origin more difficult than ever, for relations of land and sea and the character of the vegetation of various regions at that remote time are imperfectly understood. Moreover, the great mountain-building phase was still in progress, and changes were in all probability taking place relatively rapidly in the physical world. That the climate was cooling and that land barriers,

barriers to rain and so on, had been increasing may be taken as probable, and if so there was almost certainly a withdrawal of the forest and a spread of grassland, leading to a multiplication of modern hoofed animals or their immediate predecessors, which were probably then, as they were to be later, the prey of mankind.

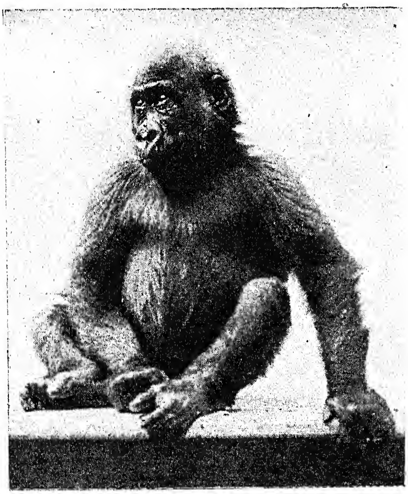

FIG. 15. Gorilla.

Many anthropologists hold that Central Asia was the region in which the most immediate ancestor of man adapted itself to a life on the ground, supporting itself on its hind limbs. They point out that it was centrally placed for migrations in all directions, and argue that Europe, the continent in which most of the remains of early man have been found, is too small an area for the evolution in different directions of the several early human stocks. They also argue from the fact that Asia has the oldest civilizations, that Central Asia is the home *par excellence* of the hoofed animals, the increasing relations between which and mankind are so very important, and they say, with some justification, that Asia has been the region where evolution in general has reached its highest development, and where changes in the form of the mountains and attendant climatic changes have been most marked. This hypothesis has received more support than it really deserved, largely because of the shadowy nature of the possible alternatives, which we may venture to sketch without claiming much value for them.

Finds both of implements and of the bones of early man have thus far been mainly in Western Europe, and the numbers of implements found are certainly very noteworthy. There were Miocene apes in Europe, some of fairly large size. There is thus just a possibility of Western Europe being the region in which the early stage of humanization occurred. This possibility is slightly increased by the fact that the climatic influences on development in Western Europe must have been powerful during the long cooling process. This cooling would diminish the rate of growth and so prolong the phases of life. We should thus get an explanation of what we have seen to be one of the most marked of human characteristics. One must always beware of overrating European evidence and objection could also be taken to the smallness of the area of Western Europe, though it remains difficult to gauge the force of that criticism.

South-west Asia and North Africa offer another possible birthplace of earliest man. Propliopithecus and Parapithecus both lived in Egypt, and they are among the apes nearest to a possible ancestral human stock. It is very widely agreed that the Gorilla and the Chimpanzee are rather more closely related to man than are the other apes, and they belong to

Africa, south of the Sahara; they are probably special types that diverged from the ape-human ancestral stock, and survived in the warm forests. Palaeolithic implements have been found in numbers in North Africa, especially in Egypt, but so far no traces of bones of really early man. It seems increasingly possible that some of the Palaeolithic cultures spread northwards into Europe from Africa, but the spread of these cultures may represent movements of mankind that occurred too long after the birth of the race to be of value as evidence here. In connexion with North Africa, including the Sahara, it may be noted that, as North Europe became cold, the winter anticyclone over the north and centre of Europe must have forced the wet westerly winds to follow a more southerly path than at present, and the Sahara, already a plateau, would thus receive at least winter rain, and would in all probability be a grassland and a possible habitat for the original men.

FIG. 16. *Australopithecus africanus*, the Taungs skull.

The skull recently discovered at Taungs, in Bechuanaland, is described in *Nature* for February 7, 1925. It shows a brain cast and a facial skeleton of an individual in which the first molar tooth only has come to the surface. This occurs typically in a six-year-old human child. The canine teeth project only very slightly and are very human, as is the jaw generally, though its forward projection is very marked. The brow ridges are not developed and the forehead rises steeply. There is a nearer approach to a chin than one finds in the Piltdown skull. The position of the *foramen magnum* shows a nearer approach to the human condition than occurs in any ape, but a far less human condition than we get in the Rhodesian man. As the specimen is obviously very young it is difficult to argue about the size of the brain, which in a human male might increase by 250 grammes in weight after passing the stage of growth shown in this specimen. The head is long and relatively high; the face is also long, a distinctly human feature. In the present state of our knowledge we may therefore say that here we have the young stage of an ape conceivably not very far from the direct ancestral line of mankind, but we should also note that young stages are generally more nearly alike than are the corresponding adults.

For speculations as to the other possible homes of the human ancestor there seems little evidence at present. Pithecanthropus lived in Java, and there are some pigmy types, who may be survivors of early man, in the Philippines and the East Indian region, while both the Veddah of Ceylon and some stocks in South India, as also the Australian stocks and the extinct Tasmanians, are very ancient types on the fringes of the East Indies or beyond. Relations of land and sea in the East Indies were probably different in Miocene and Pliocene times from what we find now, but speculation in this direction is of doubtful value in our present state of ignorance.

The most favourable temperature of the surrounding air for the physiological processes of the human body seems to be about 60° to 63° Fahrenheit, and this fact may be a clue to the problem we have discussed; but to apply it in the present state of our knowledge of climates of the past would be too venturesome. It would seem an argument rather in favour of the North-east African than of the Central Asiatic or the East Indian region, or even that of Western Europe, but one cannot say more. The reduction of hair on the body, again, suggests a moderate climate, and a non-forested region, for in a forest naked skin would be dangerous unless very tough.

Of the changes in bodily activity involved in the establishment of man as a species one may say, by way of summary, that these were: increase of the period of gestation; increase of brain-growth; reduction of jaw-growth and jaw-muscle, following elaboration of the hands and perfecting of the thumbs; development of stereoscopic vision and of refinement of the ear, and of the memorization of sights and sounds; all accompanied by marked alterations towards a more erect posture, which was nevertheless still imperfectly attained in the case of many early men; reduction of hair on the body; and the differentiation of labour between the sexes. The reduction of jaws, connected with the evolution of the hands and implements to share their work, carried with it especially the reduction of the canine teeth previously large and interlocking, and the lower jaw was thus enabled to move far more freely instead of simply up and down and from side to side obliquely as it seems to have done among the apes. It seems likely that this increased freedom of the jaws is a factor of the elaboration of speech.

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5

The Ice Age

Every one to-day has heard of the Ice Age, yet a century ago such an event had not been thought of, or more accurately speaking had been thought of by one man alone, and he lacked the opportunity to publish his views.

Early in the nineteenth century, when geology was still in its youth, scientific men were much interested in erratic blocks, that is stray masses different from the neighbouring strata, and they expressed great curiosity as to how these large masses had been carried so far from the parent rock. Many solutions were suggested, and that which gained most favour was that they had been borne by floods from their original position.

In 1802 Dr. John Playfair, Professor of Mathematics in the University of Edinburgh, in a volume entitled *Illustrations of the Huttonian Theory of the Earth,* hazarded the opinion that they had been transported by ice, but he made no attempt to follow up the subject. A few years later a guide at Chamounix, Deville by name, speaking of certain blocks, lying very distant from the present moraines, attributed their transport to the action of glaciers. This opinion, given verbally, was quoted in 1821 by Cyprien Prosper Brard, a mining engineer in Paris, in an article entitled 'Glacières naturelles' in vol. xix of the *Dictionnaire des Sciences naturelles.* In spite of these two pronouncements, the view that erratic blocks had been transported by ice gained very little support, though Goethe, when writing in 1827 the second half of *Wilhelm Meisters Wander-*

jahre, which was first published in 1829, makes reference to this opinion as a settled fact.

But in the same year that Brard's article appeared, M. J. Venetz, then the Director of Mines at Bex, in the Canton du Valais, set out in writing the results of his inquiries into the

FIG. 17. View of the Roseg and Tschierva glaciers in the Bernina Alps.

same problem. In this paper he maintained that the glaciers of the Canton du Valais and the adjacent lands had at one time had a much greater extension than in his time, and that, in consequence, the climate must, at one time, have been infinitely more severe than at present. This paper, entitled 'Mémoire sur la température dans les Alpes', was read before the Société Helvétique des Sciences naturelles, but was not published until the appearance of the first volume of their *Mémoires* in 1833.

These views were communicated by M. Venetz to his colleague M. Jean de Charpentier, Director of Mines for the Canton de Vaud and Honorary Professor of Geology at the Academy of Lausanne. At first M. Charpentier was inclined to disbelieve in the new hypothesis, and for a time combated it warmly. When, however, it appeared in print he was converted, and began to study the question afresh. This resulted in a paper, read in 1834 before the same Société Helvétique, which appeared in the eighth volume of the *Annales des Mines*, and in the first volume of Fröbel and Heer's *Mittheilungen aus dem Gebiet der theoretischen Erdkunde*. This paper aroused considerable interest, and Dr. Louis Agassiz, who was present, urged the author to extend his investigations, while he himself began to study the subject.

Agassiz, then a professor at the Academy of Neuchâtel, spent much of his leisure tramping along the slopes of the Jura mountains, looking for evidence of ice-borne blocks. He was accompanied in his rambles by Karl Friederich Schimper, Professor of Botany at the University of Munich, who was equally interested in the new hypothesis. In the winter of 1836–7 Agassiz gave a series of lectures on this subject to his students, while Schimper, fearing that the matter would be received with scorn by his contemporaries, as were the views of Galileo, decided not to embody his ideas in a scientific paper, but composed a fanciful poem, entitled 'Die Eiszeit', which he had printed and distributed to the members of his friend's class; it was afterwards reprinted and published in 1841.

On the 1st March 1837 M. Godet read a paper before the Natural History Society of Neuchâtel, dealing with the erratic blocks that cover a great part of Scania, the peninsula at the south end of Sweden. Professor Agassiz, who was

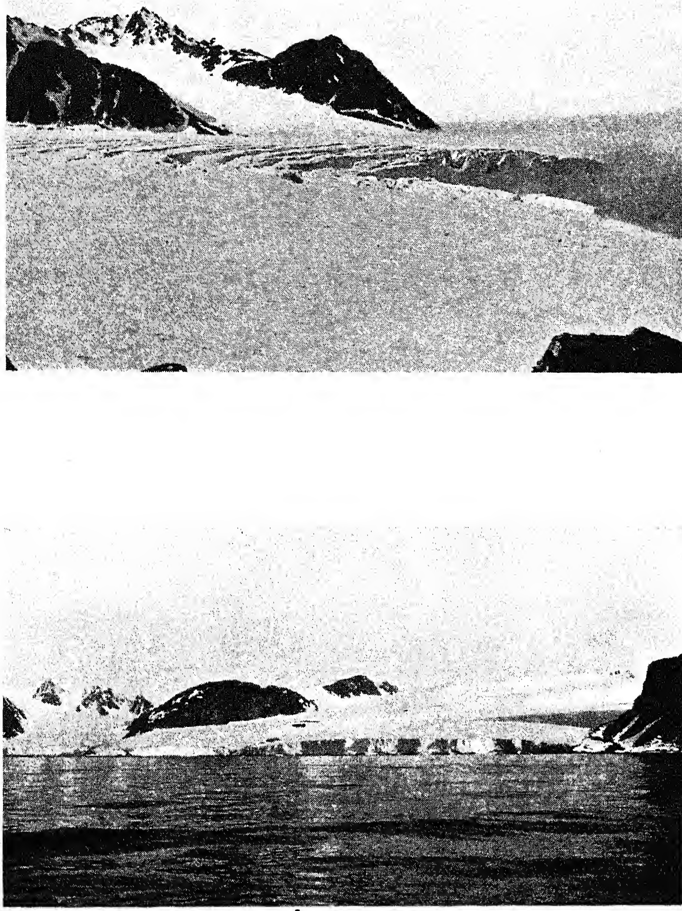

FIG. 18. Glaciers. The upper illustration is of one in Magdalena Bay; the lower is of another immediately south of the bay. Photographs by the Oxford Spitzbergen Expedition 1925.

present, suggested in the discussion which followed, that the presence of these blocks could be attributed to immense sheets of ice, which had covered that region in the period which immediately preceded the present period of recent life.

But it was on the 24th July of the same year that Professor Louis Agassiz, in his presidential address to the Société Helvétique, which opened the meeting held that year at Solothurn, propounded to the world that there had been a period of great cold, which preceded the period of recent life, and to which he referred the erratic blocks found in great numbers in the neighbourhood of the Jura, and the remains of mammoths found in the frozen tundra of Siberia. In this paper he very generously acknowledged the work of his predecessors, but by most subsequent writers this address has been looked upon as the introduction to the world of the Glacial Hypothesis.

Charpentier gave a further *résumé* of his views at a meeting of the Geological section of the same society held at Basle on the 14th September 1838, and in 1840 Agassiz brought out a handsome volume, entitled *Études sur les glaciers*, accompanied by an atlas showing the distribution of the erratic blocks; in the course of the same summer he attended the meeting of the British Association at Glasgow and gave there a summary of his views.

That year the hypothesis was accepted by many of the prominent geologists in this and other countries; M. Godefroy published in Paris his *Notice sur les glaciers, les moraines et les blocs erratiques des Alpes*, while M. le Chanoine Rendu published at Chambéry his *Théorie des glaciers de la Savoie*, in which he combated the whole theory. Lastly in 1841 Charpentier published in Lausanne his great work on the subject, *Essai sur les glaciers et sur le terrain erratique du bassin du Rhône*.

The hypothesis was warmly supported in this country by Forbes and Tyndall, who not only studied the glaciers and the evidence of their former expansion in the Alpine region, but found ample data in support of this view in the British Isles, especially in the regions north of the Thames. Of course there were many opponents to the new theory, but they were

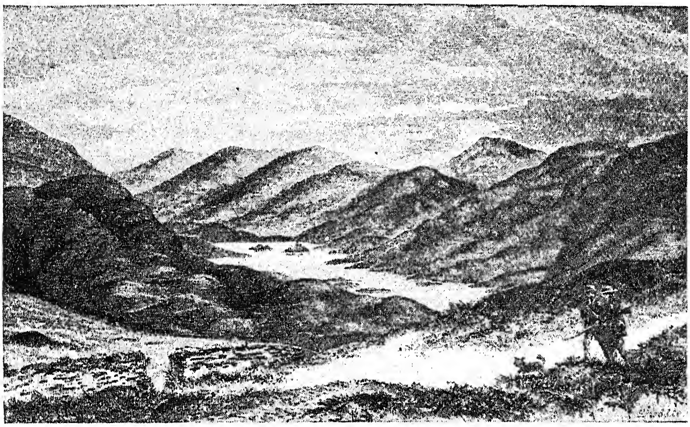

FIG. 19. Roches moutonnées, around Loch Doon. (After James Geikie.)

unable to explain away the ever-increasing mass of evidence that was collected, ultimately even from America, both North, Central, and South, from Australia and New Zealand, and even from the mountains in tropical East Africa. So the opposition died of inanition, and the Ice Age is to-day considered as an established fact.

This fact is briefly that at a period in the past, roughly corresponding with the Pleistocene epoch, the temperature in many parts of the world grew so cold and the snowfall so heavy that in mountain regions the permanent snow extended several thousand feet below its present line, while the glaciers were prolonged for some hundreds of miles down their valleys. Meanwhile in more northern latitudes vast sheets of ice extended from the Arctic regions down, in some cases to latitude 50°, and in North America even to latitude 40°. These ice sheets covered all the lowlands and even much of the mountains except the highest peaks, and as evidence of this it was pointed out how all the hills in Wales below 2,000 feet and in Scotland and Scandinavia below an altitude of 3,000 feet, have been ground down to smooth rounded outlines, while no craggy peaks are found until we rise above this level.

In the year 1854 A. Morlot discovered near Dürnten, on the edge of Zürich Lake, a bed of fossil plants, of a type which grow only in south temperate climes, lying above one and beneath another great deposit of glacial origin. This led him to realize that the glacial periods had been more than one, and that these had been separated by genial phases, when the temperature was somewhat warmer than at present. Morlot advanced the theory that there had been three glacial stages, separated by two interglacial intervals. This view was not well received at first, though it gained some supporters, who found remains of plants and animals, adapted to warmer climates, in deposits lying between those laid down in the colder phases. Besides this it was pointed out that in some places there were successive moraines in the same valley, and successive terraces beside several rivers, and that all these pointed to a succession of glacial periods.

In 1871 James Geikie, Professor of Geology in Edinburgh University, brought out the first edition of his famous work *The Great Ice Age and its Relation to the Antiquity of Man.* In 1881 he published his *Prehistoric Europe*, in which he first developed the idea that the evidence in Scotland, and in

North Europe generally, pointed to the former existence of six distinct glacial periods.

This polyglacial, or preferably multiglacial, view was not well received, and considerable opposition was offered to it, both in this country and in Scandinavia, by its opponents of the monoglacial or uniglacial school. It received, however, considerable support from America, where it was upheld by T. Chamberlin in 1895, in his *Glacial Studies in Greenland*, and still more in 1905 in his *Geology*.

Little further progress was made until the beginning of the present century, when Dr. Albrecht Penck and E. Brückner

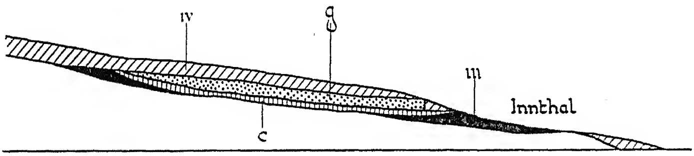

FIG. 20. Section at Hötting. (After Penck and Brückner.)

made their famous study of the evidences of the glacial period in the Alpine region. Their great work, *Die Alpen im Eiszeitalter*, was published in three volumes at Leipzig between 1901 and 1909, and this has placed the whole problem of the division of the Ice Age on a surer foundation.

By studying what was left of the old moraines, especially terminal moraines, Penck and Brückner were convinced that there had been in the Alpine region four great glacial periods of differing intensities. They proved, too, not only from the Dürnten plant remains, but from similar deposits at Hötting, near Innsbruck, that the intervening periods, or some of them, were fairly mild. They further proved the correspondence between these four glaciations and the successive gravel terraces of the Rhine and other rivers.

These four glacial periods they named after certain valleys in which evidence of their existence occurred, the Günz, Mindel, Riss, and Wurm. These names were selected for a definite purpose, because their initial letters lie in the same order in the alphabet, and the authors contemplated that, if several intermediate zones were afterwards established, names could be found for them which would fall into the same scheme.

The Würm glaciation was thought to be twofold, or to have had two periods of maximum intensity, with a period of relative mildness intervening, when the glaciers somewhat retreated. This intervening period they termed the Laufen retreat, though they now believe it to have been slighter, and the amelioration less, than they first imagined. The Würmian ice, according to these writers, retreated slowly and by no means uniformly, for on one occasion there was a slight advance for a time, and on two others a pause in the retreat; to these episodes they gave names based upon the Greek alphabet, for they recognized four stages:

α. The Achen oscillation, when the ice retreated slowly with many small oscillations.

β. The Bühl stadium, when the ice somewhat advanced for a time.

Then after a further retreat,

γ. The Gschnitz stadium, when for a time the glaciers ceased to retreat.

Again after a further retreat,

δ. The Daun stadium, when the glaciers again for a time stood still.

As a result of further detailed studies of the Swiss moraines, Penck has somewhat modified his views concerning the retreat of the Würm glaciers. These will be discussed more fully in the next part of this series; it will be sufficient to state here that these new opinions suggest that the second maximum of the Würm involved a very slight advance of the ice, that several similar though smaller advances occurred during the Achen oscillation, and that the Bühl advance consisted of several small rather than one larger advance of the glaciers. Some continental geologists also recognize a period of relative cold during the Riss-Würm interglacial stage.

Some writers have even attempted to omit the Riss-Würm interglacial stage altogether, and to argue that it was a cold period throughout, very similar indeed to the Achen oscillation, and that the Würm glaciation was but a temporary advance during the long retreat of the Riss glaciers. This opinion is based, to some extent, on certain novel views of the Hötting beds recently expressed by Professor R. Lepsius.

These beds, which contain remains of plants, such as the common rhododendron, requiring a relatively mild climate, lie beneath the moraine of the Würm and above that of the Riss glacier of the Inn valley. Professor Lepsius now denies this. He states, quite truly, that the Hötting beds consist of two layers, one of red clay and one of white, and that it is in the white layer only that plant remains are found. So far he is in agreement with other observers. But he states, further, that the white is the older and that it is only the red clay which lies between the two moraines. The finest collection of plant remains, however, was made by von Wettstein, who clearly states that he found several red and white layers lying one above the other, while Penck is equally emphatic that he found the white clay resting on the red. We cannot disregard such well-established evidence, and must conclude that not only the red layers, but also the white clays containing the rhododendron and other plant remains, were laid down in the period between the Riss and the Würm glaciations. This implies a warmer climate than at present, for to-day the Pontic rhododendron will not grow in the open on the hill side at Hötting.

Fig. 21. Fossil rhododendron from Hötting breccia. Flowering branch of Rhododendron.

This hypothesis of Penck and Brückner met with very general agreement in Germany, Austria, and Switzerland, and was approved by many of the savants in France. Boule, however, while accepting the last three glaciations, said that he could find no evidence for the Günz Ice Age in France. It is now generally admitted that this is true for the western or north-western part of that country.

In this country, however, though the multiglacial theory received from the beginning the warmest support from Professor Sollas, it met with very general opposition from other geologists, whose views on the subject were well summarized by G. W. Lamplugh, in his presidential address to the Geological Section of the British Association at York in 1906. In Scandinavia it fared little better, where N. O. Holst opposed it in several papers published between 1909 and 1915. In America the view was contested by W. B. Wright, in his *Quaternary Ice Age* published in 1914, but had received strong support from F. Leverett in his 'Comparison of North American and European Glacial Deposits' published in the *Zeitschrift für Gletscherkunde* 1910. On the other hand most students of prehistoric archaeology in all these countries were disposed to accept this system, and various attempts were made to bring the views of the multiglacialists and uniglacialists into line.

It was suggested by some that the fourfold system of glaciation might be true for Central Europe, but that in more northern latitudes the amelioration of the climate was so slight as to cause little if any diminution of the ice sheet, while others suggested that the Würmian ice sheet was so violent in its actions as to destroy all evidence of previous glaciation. One of the present authors hazarded the suggestion that, just as the Würmian glaciation had two maxima, this might be a characteristic feature of all glaciations, and that perhaps Günz and Mindel were but two maxima of the first of these glaciations. This view was very favourably received in America, where it still meets with some support, but the promoter feels that the evidence which follows makes it a less probable solution than it appeared to him at the time when he first advanced it.

In 1922 Dr. P. G. H. Boswell, and Mr. J. Reid Moir explored certain deposits beneath the Foxhall Road Brickyard at Ipswich. Here they distinguished fourteen layers of deposits, the lowest being Chalky-Kimmeridgic boulder clay. As a result of their investigations Professor Boswell came to the conclusion that in the east of England there was evidence of three successive boulder clays, laid down by three successive ice sheets, though the nature of each deposit varied considerably in different regions. These boulder clays he arranged thus:

3. Hessle boulder clay, Intensely chalky boulder clay.
2. Purple boulder clay, Chalky-Kimmeridgic boulder clay.
1. Basement boulder clay, Norwich brick-earth, North Sea drift, Cromer till, Contorted drift.

Thus the evidence from East Anglia seems to show three out of the four glaciations of Penck and Brückner.

In the discussions which followed the reading of this paper before the Royal Anthropological Institute in 1922, one of the present writers pointed out that, though from the evidence adduced three glaciations in this country seemed well established, there was nothing to show which three of the Penck-Brückner series they were. He suggested, however, that as evidence for the Günz glaciation appeared to be absent in North-west France, it was likely that this might be the case here too. He suggested that perhaps the Günz glaciation was confined to the Alpine region, or had its centre more to the eastwards than its successors; in either case some evidence should be found of a cold, though not glacial, period preceding the period of the North Sea drift. In his reply Professor Boswell expressed himself in general agreement with these remarks, and said that the cold period required could be found in that in which the Weybourn Crag was laid down.

This paper, which was published in the *Journal of the Royal Anthropological Institute* late in 1923, is of extreme importance in coming to a conclusion on this subject. Professor Boswell had up to this time been looked upon as a member of the uniglacial school, and his definite pronouncement in favour of multiglaciation is likely to have far-reaching effects. The uniglacialists have not yet replied, perhaps they will not do so.

While Penck and Brückner were engaged on their great work, Blanckenhorn published in the *Zeitschrift der Gesellschaft für Erdkunde* of Berlin for 1902 a paper entitled 'Geschichte des Nil-Stroms'. In this he endeavoured to show that in Egypt, in the valley of the Nile, there was evidence of four very wet

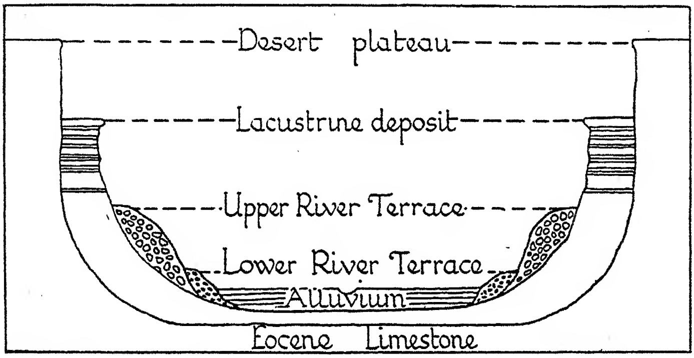

FIG. 22. Section of the Nile Valley.

periods, or pluvial periods as he called them; these he brought into relation with the four glacial periods already foreshadowed by Penck and Brückner. Blanckenhorn's evidence is far from being either clear or convincing, but it has been very ably summarized by Professor Breasted, in such a way as to make it, in its English guise, much more attractive than it is in the original. As yet few writers have paid much attention to this hypothesis, though Professor J. L. Myres, in his brilliant chapters in the *Cambridge Ancient History*, has used it as his basis for Pleistocene chronology. If indeed these pluvial periods are to be considered the equivalents of glacial periods elsewhere, it seems more likely that their true relations are rather with the Mindel, Riss, Würm, and Buhl, than with the four great glaciations.

In recent years a further hypothesis has been advanced in France by Professor Depéret and General Lamothe, in various papers published between 1916 and 1922. General Lamothe noticed four terraces or raised beaches on the coast of Algeria, occurring at 15, 28–30, 55–57, and 93 metres above the present sea-level, and subsequently he compared these with the four terraces noted by Commont in the Somme valley. Depéret associated these with other similar raised beaches noted in Sicily, Tunisia, and elsewhere in the Mediterranean region. He therefore suggests that the Pleistocene should be divided into four stages, which he names after the most conspicuous beaches, the Sicilian, Milazzian, Tyrrhenian, and Monasterian. He has further attempted to establish a relation between these and the four glacial periods of Penck and Brückner. Professor Sollas, who very ably summarized these views in January 1923, suggests that both the marine and river terraces, which seem to be evidence of slight marine transgression, should be relegated to the milder periods preceding the four glaciations, during which, he thinks, the sea receded.

This hypothesis is certainly very tempting, connecting as it does in one clear hypothesis the marine and river terraces with the glacial periods; but in spite of the powerful advocacy of Professor Sollas it must be admitted that the uniformity of those beaches around the Mediterranean is not yet sufficiently demonstrated.

There is ample evidence that during the Ice Age the relative positions of land and sea were not always as they are at present; on the one hand we have evidence of terraces or raised beaches, sometimes as much as a hundred metres above the present coast-line, showing considerable oceanic transgression, while on the other signs are not wanting of ancient coast-lines, which are considered to be of this date, now sunk a hundred fathoms or more below the present sea-level.

W. Ramsay has recently issued a study of the movements of the earth's crust during late Pleistocene times in Fenno-Scandia and throughout the whole of the Baltic region. He thinks that during the Pleistocene period Scandinavia was, on the whole, sinking until it reached a few metres below its present level. He calculates that this process went on at such a rate that the land sank from 50 to 80 metres, or on an average 65 metres, between the times when the Daniglacial and the Fenno-Scandian moraines were laid down, that is to say while the Wurmian ice sheet was retreating across the southern half of Sweden. He would, however, subject this to a correction to be explained later.

If we are prepared to accept this view, we may argue that in earlier Pleistocene times the Scandinavian peninsula stood still higher, and that at the close of the Pliocene period the shore-line lay as far out at least as the 500 fathom line, and in all probability lay further out still, perhaps as far as the 1,000 fathom line. If the coast-line lay only just beyond the 500 fathom line, the shallow area known as the Wyville-Thomson ridge would have been above sea-level and have formed a continuous belt of land joining Scotland and Norway on the one side to Greenland on the other. The result of this would have been that the Atlantic Ocean adjoining the western coast of Europe would have been cut off from the cold water of the Arctic.

While, therefore, the then height of Scandinavia may have involved that region in glaciation, so that an ice sheet covered the whole of the Baltic region, and while similar causes may have led to the extension of the glaciers and snow fields in the

Alps, the warm currents of the Atlantic, unmixed with the colder waters of the Arctic Ocean, may have kept Western Europe free from extremely cold conditions. This may account for the absence of any evidence of truly glacial con-

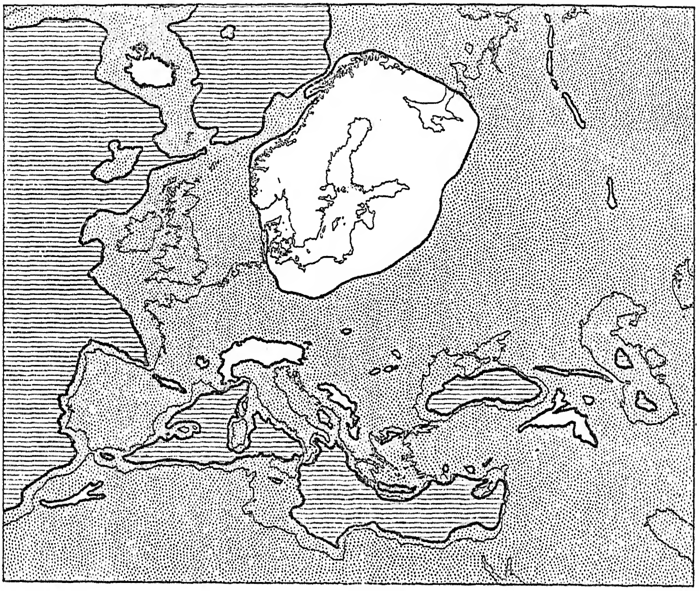

FIG. 23. Conjectural map of Europe during the Günz glaciation.

ditions in England and Western France during the Günz glaciation.

As the sinking continued, part of the Wyville-Thomson ridge sank below sea-level and the two oceans became united, and the points of contact between them gradually increased. If this were so, we have an hypothesis to account for the increased influence of subsequent glaciations upon the western areas of Europe. Finally, as Scandinavia continued to sink, a level was reached when its mountains were not high enough to engender ice sheets as large as before, and the warmer waters of the Atlantic were able to exert an influence over the colder

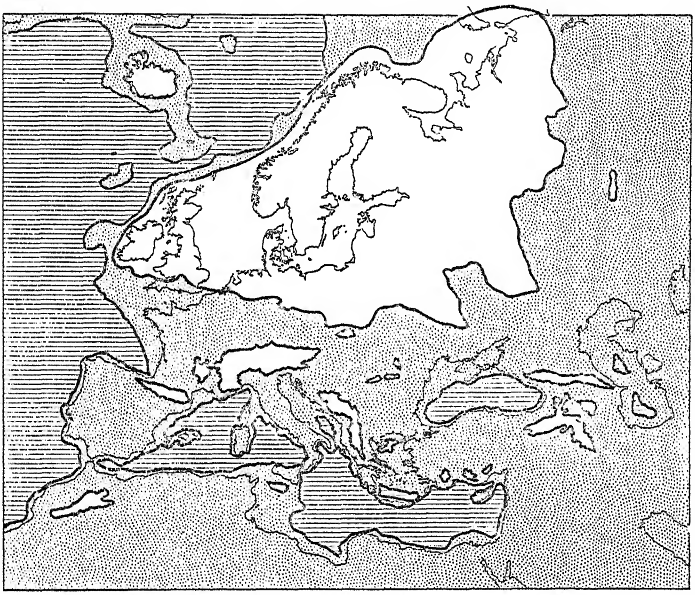

FIG. 24. Conjectural map of Europe during the Mindel glaciation.

waters of the coast of Norway. This enables us to form a mental picture of the passing of the Ice Age.

The above must not be taken as a complete outline of the relations between land and sea in the Baltic region during the Pleistocene period, for other factors must also be taken into consideration. In the first place Jamieson has convinced most students that the weight of ice upon the Scandinavian highlands during the ice ages was sufficient to press the land down to some extent. Nansen has estimated that the ice sheets, which at various times covered the peninsula, must have had a thickness of at least 600 metres, while Ramsay suggests increasing this estimate to 1,200 metres. It would seem that this huge mass of ice must have depressed the peninsula, and, according to Madson (1923), there may have been a slight compensating, or as it is called isostatic, uprise in Denmark and other regions around the margin of the ice sheet. Such uprises may well have delayed the more complete submergence of the Wyville-Thomson ridge.

There is still another complication. The great ice sheets of the Pleistocene period locked up immense quantities of water, and Penck, Daly, Drygalski, Nansen, and W. Ramsay have made various estimates of the consequent lowering of the ocean-level. These estimates range from 23 to 300 metres, but a moderate average estimate of 130 metres seems to have been reached by Nansen in 1922. This lowering of the water-level in the ocean was undoubtedly one of the factors which led to the emergence of the land above sea-level during the ice ages.

These arguments reinforce Sollas' interpretation of Depéret and Lamothe's hypothesis, which suggests that the advances of the sea, in Mediterranean and Atlantic Europe at least, took place during the relatively warm interglacial phases.

De Geer and Högbom think that there has been an uplift of the Scandinavian highlands since the melting of the ice. This uplift varies from 0 in Denmark and North Germany to about 284 metres in the northern moorlands of Scandinavia. Such an emergence would give broad unions between England and the Continent, both across the North Sea and the English Channel, if the sea-level were lowered even by 80 metres.

As to the cause of the ice ages much has been written with, however, little satisfactory result. Croll, following some suggestions made by Adhemar, put forward the view that glaciation was due to the combination of two circumstances,

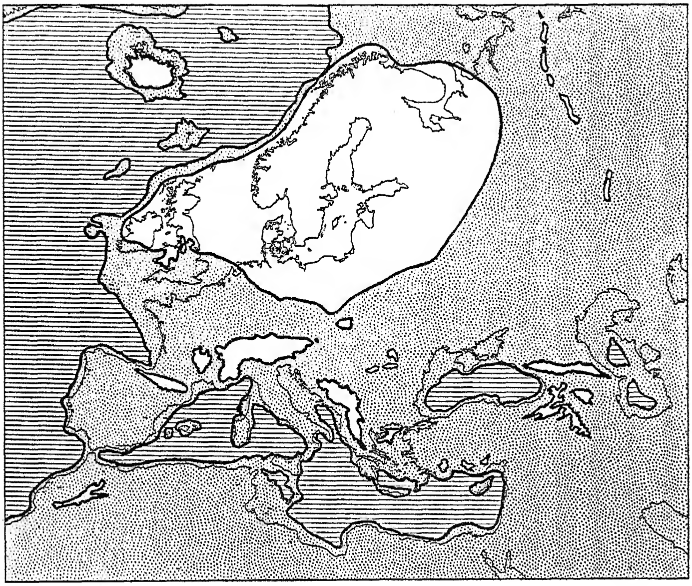

FIG. 25. Conjectural map of Europe during the Riss glaciation.

arising from the precession of the equinoxes and the changes in the eccentricity of the earth's orbit. This explanation was very popular at one time, but is now much less so. Others have suggested that the polar axis has shifted from time to time, and with it the polar regions; but no one has seriously suggested a shift which would bring Scandinavia nearer to the pole. Others again have suggested that during glacial epochs the world has been travelling through unusually cold areas of space.

Burkitt says that the late Professor McKenny Hughes at one time suggested that changes in geographical conditions, and in the altitude of certain lands, might produce glacial conditions in the upraised areas. A very similar hypothesis has recently been advanced by Mr. C. E. P. Brooks. He argues that climatic conditions have changed from time to time as a result of changes of coast-line, which have affected both water and air currents, and that owing to the higher levels of land which are known to have obtained during the Pleistocene period, the storm zones, which now cross the British Isles and the Baltic Sea, would have moved as far south as the Mediterranean, while the Arctic anticyclonic zone would have been correspondingly extended. This view of the cause of the Ice Age, while by no means universally accepted as a proven fact, is much in favour in many quarters at the present time, and its probability is increased if the suggestions, which we have just made, with respect to the rise of the Wyville-Thomson ridge, are regarded as likely.

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6

Early Tools

From a very early period it was realized that there had been a time when metal was unknown. In the Book of Genesis it is stated that Tubal-Cain, the seventh in descent from Adam, was the first to instruct men how to work in bronze; Hesiod, too, while mentioning that the use of bronze preceded that of iron, clearly intimates that man existed prior to the discovery of that alloy. But Lucretius, who wrote his poem, 'De Rerum Natura,' about 58 B. C., was the first to state explicitly that before metal was known, men had used tools of stone and boughs of wood.

For many centuries after this men seem to have been uninterested in their early beginnings, and though stone implements were often found, and generally used as amulets, a curious folk-lore survival, we find no further mention of the early use of such implements until Sir William Dugdale in his *Antiquities of Warwickshire*, published in 1650, wrote of stone celts as 'weapons used by the Britons before the art of making arms of brass or iron was known'. Père Montfaucon in his *Antiquité expliquée*, published in 1722, described the discovery at Évreux of some skeletons with stone hatchets alongside of them, and added, 'it appears that these barbarians had not any use either of iron or copper or of any other metal', and Nicholas Mahudel in 1734 read a paper, entitled 'Sur les prétendues pierres de foudre', which was published in the *Histoire de l'Académie des Inscriptions* in 1740. In 1750 Eckard, in his work on the origin of the Germans, refers to the subject, as did Goguet in 1758, in his *Origins of Laws, Arts and Sciences*, and Bishop Lyttleton in his *Observations on Stone Hatchets* in 1766. But it was a Dane, Christian Thomsen, the Director of the National Museum in Copenhagen, who in 1836 first suggested that there had been a definite Stone Age, and arranged his collections on that basis.

Up to this time surface finds, consisting mainly of polished celts and arrow-heads, had attracted the attention of archaeologists, but in 1841 M. Boucher de Perthes, head of the custom-house at Abbeville, collected at Menchecourt worked flints from the gravels of the Somme, where they were found in deposits containing the bones of extinct mammals. In 1846 he published a volume on these discoveries, entitled *De l'Industrie primitive, ou les Arts et leurs origines*, and in the following year another under the title of *Antiquités celtiques et antédiluviennes*. This discovery, as well as the inferences drawn from it, was received with universal scepticism, until in 1853, Dr. Rigolot examined similar gravels at St. Acheul, near Amiens, found several implements and was converted. Two years later he published his opinion in a *Mémoire sur des Instruments en silex trouvés à St. Acheul, près Amiens*, but the new opinions continued to be viewed with distrust.

In 1858 Dr. Hugh Falconer, the English geologist, happened to be passing through Abbeville and saw the collection of M. Boucher de Perthes, and was convinced of the value of these discoveries. He informed some of his English colleagues, and early in April in the following year he paid another visit to the site, accompanied by Professor, afterwards Sir Joseph Prestwich, and Mr., afterwards Sir John Evans, who took with him his little boy Arthur, now Sir Arthur Evans. These English scientists were at once satisfied that they were dealing with objects that were the works of man, and had been fashioned when beasts, long extinct, had lived in the north of France. Immediately on their return, on the 19th May 1859, Prestwich communicated a paper on the subject to the Royal Society,

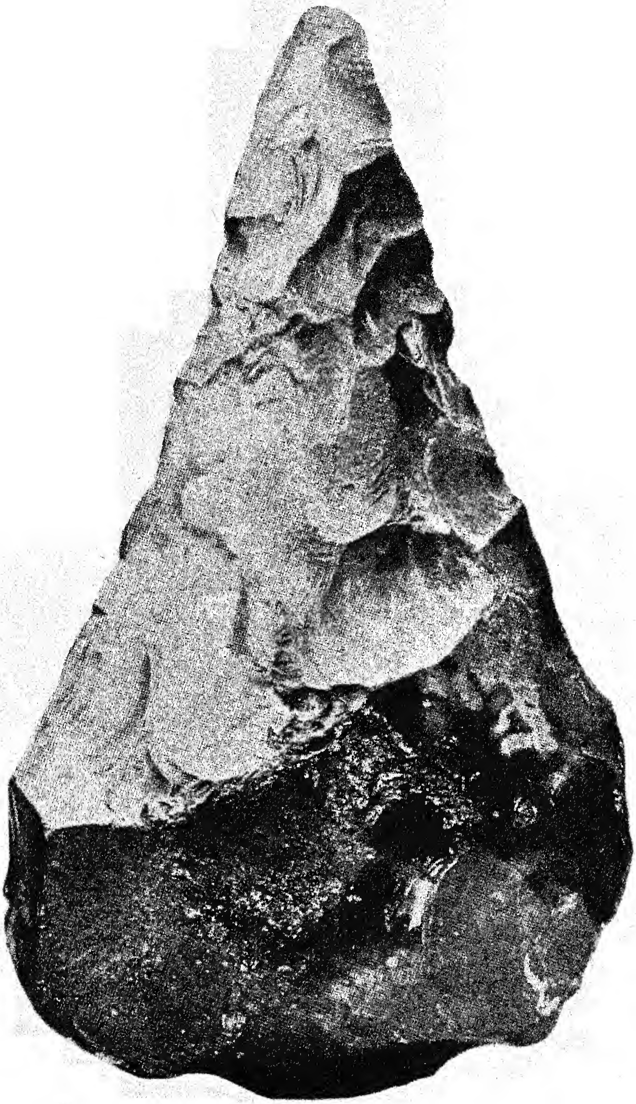

Fig. 26. Implement found in Gray's Inn Lane.

while Evans read a paper on the implements before the Society of Antiquaries on the 2nd June of the same year, which was that in which Darwin and Wallace gave their paper, 'The Origin of Species.' On his return to England, Evans found a record of the discovery of similar implements at Hoxne in Suffolk, by Mr. J. Frere in 1797, and at the British Museum another implement, discovered in Gray's Inn Lane, London, together with an elephant's tooth, by Mr. Conyers in 1690.

The authenticity of these finds in the gravel drift of the Somme valley was thus definitely established, and fresh discoveries were soon made in similar deposits in England. In the next year Édouard Lartet and Milne Edwards began explorations of caves in central and southern France, and the former published his conclusions in 1861 in the *Annales des Sciences naturelles.* With Mr. Henry Christy he continued his investigations for some years, and in 1864 they published jointly a brief account of their work, though it was not until 1875, after the death of both explorers, that their *magnum opus*, *Reliquiae Aquitanicae*, was given to the world.

Meanwhile, in 1865, Sir John Lubbock, afterwards Lord Avebury, suggested the division of the Stone Age into two, the Palaeolithic or Old Stone Age, to include remains from the gravels and the caves, while the surface finds and implements from tombs he relegated to the Neolithic or New Stone Age. After the discoveries of Lartet and Christy had become well known, it was recognized that the Palaeolithic Age must be subdivided into two periods, the Drift Period and the Cave Period.

Many more discoveries, both in the drift and in caves, in France, in the British Isles, and elsewhere, were made in rapid succession, and it was found that there were different types of Palaeolithic implements, sometimes in different strata, in both classes of sites. The study of these objects advanced considerably when in 1869 Gabriel de Mortillet produced a paper on the classification of such implements. This able archaeologist recognized five stages of culture within the Palaeolithic Age, which he named after the sites where the most typical specimens had first been found; for reasons based on the relative positions of strata, he placed them in the following order, the earliest at the bottom.[1]

5. Magdalenian.	Cave of La Madeleine, near Les Eyzies, Dordogne; fine flint flakes and numerous bone implements.
4. Solutréan.	Solutré, near Mâcon, Saône-et-Loire; beautifully worked leaf-like implements.
3. Mousterian.	Moustier, a rock shelter near Les Eyzies; flints mainly worked on one side only.
2. Acheulean.	St. Acheul, near Amiens, Somme; the hand-axes of St. Acheul.
1. Chellean.	Chelles-sur-Marne, Seine-et-Marne; bold, partly worked hand-axes.

In 1896 É. Piette made some important discoveries of a new and later culture in the cave of Mas d'Azil, Ariège, and described an industry which he called Azilian. This was for many years considered as an early stage of Neolithic culture, then it was placed at the close of the Palaeolithic Age, where it is, by most authorities, considered more properly to belong. Some writers have, however, quite recently suggested that this, and some later cultures, should together form a Mesolithic Age. About the same time many archaeologists became interested in certain types of pigmy flints, which, though found on many sites, were especially plentiful at Fère-en-Tardenoise, Aisne. These were thought by G. de Mortillet

[1] This table was subsequently amplified, see pages 88 and 99.

to belong to some part of the Neolithic Age, and were termed by him the Tardenoisian industry. In 1912 the Abbé Breuil and H. Obermaier found flints of this type in the cave of Valle in North Spain, together with typical Azilian remains, and the two cultures are now considered to be contemporary.

In 1906 Breuil came to the conclusion, which he had been suspecting for some years, that many of the flints hitherto believed to be Magdalenian, were anterior to Solutréan. A careful examination of the evidence proved this to be the case, and so at the meeting of the International Congress of Anthropology and Prehistoric Archaeology, which met at Monaco that year, he announced this conclusion, which met with general acceptance, and he termed this culture Aurignacian, from the cave of Aurignac, Haute-Garonne.

Thus at this time there were seven stages of the Palaeolithic Age generally recognized and accepted, those named from Chelles, St. Acheul, Moustier, Aurignac, Solutré, La Madeleine, and Mas d'Azil. Of these the two first, which have been found only in the drift, are considered as belonging to the Lower Palaeolithic, the third, found both in the drift and in the caves, constitutes the Middle Palaeolithic, while the remainder form the Upper Palaeolithic, unless, following recent suggestions, we transfer the Azilio-Tardenoisian culture to a new Mesolithic Age. In this volume we propose to deal only with the Lower and Middle Palaeolithic cultures, leaving the Upper Palaeolithic industries for a future volume.

Ever since 1867 there had been some writers who claimed that they had found humanly fashioned flints far older than those of Chellean type. In that year M. l'Abbé Bourgeois, director of the College of Pontlevoy, described certain flints from an Upper Oligocene deposit at Thenay, which he maintained had been humanly fashioned. The artificial nature of these flints was vigorously denied by most archaeologists at the time, and, to-day, few, if any, believe them to be the work of man. These, and other implements of pre-palaeolithic type, were in 1900 relegated by G. de Mortillet to an Eolithic Age.

The best known type of eolith is that found in considerable numbers by the late Benjamin Harrison on the plateaux near

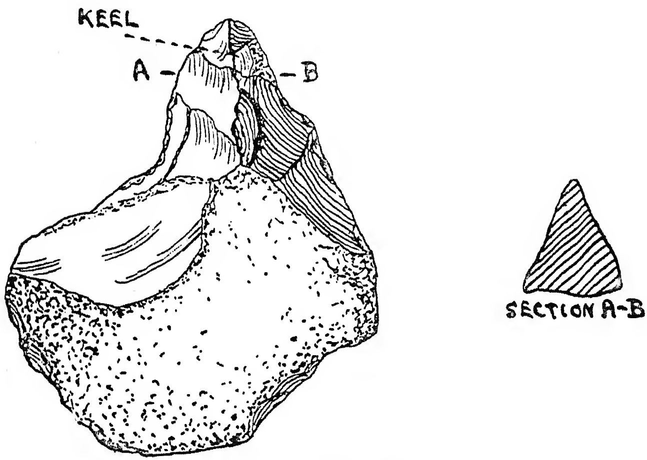

FIG. 27. Eoliths, Kent.

Ightham in Kent. In 1889 they were brought to the notice of Sir Joseph Prestwich, who read a paper about them before the Geological Society; on the other hand, Sir John Evans denied that they were of human workmanship. Since then they have been found on many sites, and in gravels of varying ages, and the students of early man are divided into two camps as to their artificial origin. They have many enthusiastic supporters, but their artificial nature has been vigorously denied by Boule, Macalister, Hazzledine Warren, and others. Rutot has been, perhaps, the most distinguished defender of their artificial character, and in 1902 he drew up a scheme, showing eight distinct stages of culture earlier than that of Chelles.

PLEISTOCENE

8. Strépyan culture of Strépy, Belgium.
7. Mesvinian culture of Mesvin, Belgium.
6. Mafflean culture of Maffle.
5. Reutelean culture of Reutel, West Flanders.

PLIOCENE

4. Prestian culture of St. Prest, Eure-et-Loir.
3. Kentian culture of the Kent plateaux.

LOWER PLIOCENE OR UPPER MIOCENE

2. Cantalian culture of Le Puy Courny, near Aurillac, Cantal.

MIDDLE OLIGOCENE

1. Fagnian culture of Boncelles, Ardennes.

The Strépyan, more often termed by others pre-Chellean, are accepted under the latter name by most archaeologists as being merely a very early type of Chellean. The Mesvinian, though very rude, have been shown recently to be contemporary with Acheulian. The two other Pleistocene cultures of this scheme are no longer recognized.

About the two Pliocene cultures, which may both be termed eoliths, controversy is still raging, though recently there have been many converts in France, owing to certain discoveries to be mentioned later. The idea that the flints from Cantal have been made by some tool-fashioning animal has lately been revived, and it has been admitted by a strong opponent of the eolithic theory that they 'are certainly more like genuine artefacts than most of the chips that have been labelled eoliths'. The Fagnian eoliths were found in 1907 by E. de Munck and A. Rutot, in a bed of Middle Oligocene Age at

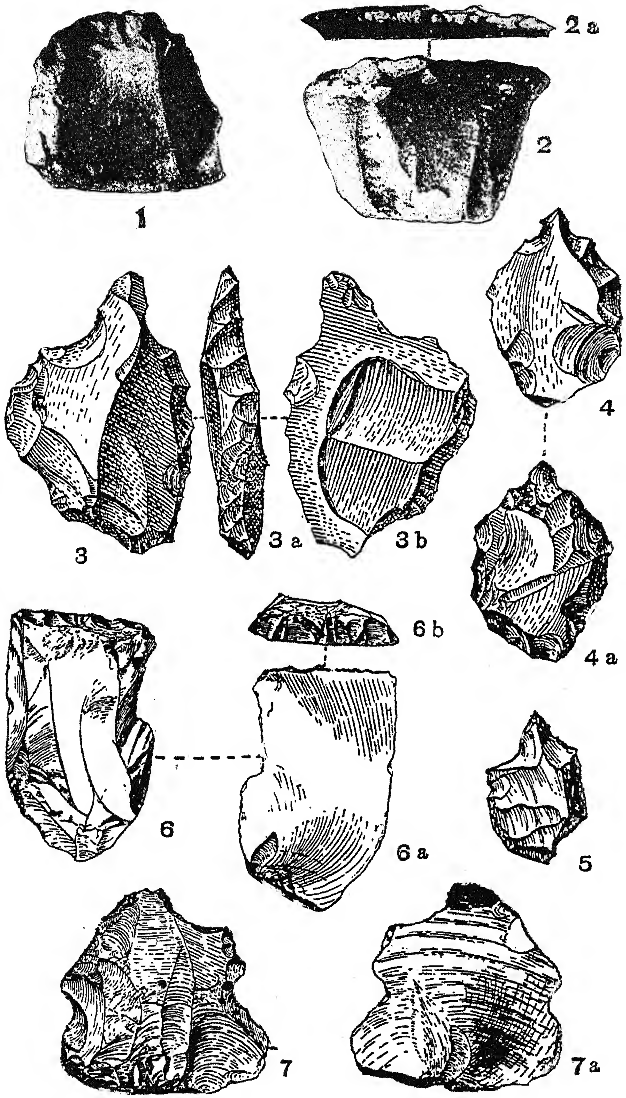

FIG. 28. Cantal eoliths.

Boncelles in the Ardennes. A committee was immediately formed to study the question *in situ*, and this committee unanimously rejected them as humanly made tools, and stated that the flaking was due to the pressure of the overlying strata.

We now come to a series of discoveries which have been made in East Anglia by Mr. J. Reid Moir. In 1910 he discovered what he believed to be implements in a deposit, which occurs under mid-glacial sands, resting unconformably upon London Clay, in the clay-pit at Ipswich. This deposit has been definitely considered to be Red Crag by competent geologists. The most important objects found here were flints of a new type, one side of which was formed like the keel of an upturned boat, while at the end there was a kind of beak. For this reason Ray Lankester called them rostro-carinate implements. Soon they were found in some other pits in the neighbourhood, but their occurrence was in no place common.

The discovery of this new type of tool was received with some scepticism by archaeologists, but the new implements received the powerful support of Sir E. Ray Lankester, who read a paper on the subject before the Royal Society. Similarly shaped flints were found in 1913 at Selsey Bill, in Sussex, by Professor Sollas, who regarded them as due to natural causes. MM. Breuil and Boule examined Mr. Moir's specimens, but rejected the idea of human workmanship.

Early in January 1919, Mr. Moir examined a pit at Foxhall, near Ipswich, and there found at a depth of sixteen feet, and several feet below the top of the Red Crag, yet thirteen feet from its base, a layer containing burnt flints, pot-boilers, bones, and flint implements for boring and scraping. M. Breuil visited the site the following year and examined the flints and expressed himself convinced that they were definitely of human workmanship. Lastly, in 1921, Mr. Moir described

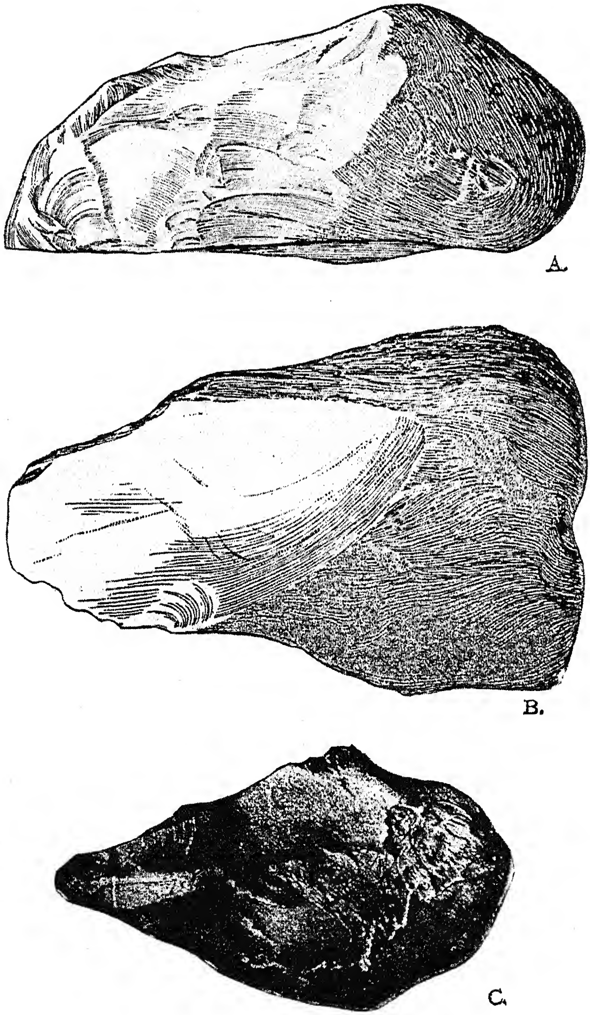

Fig. 29. Rostro-carinate implements.

a number of implements, which he considered to be of early Chellean type, which he had found on the foreshore at Cromer, and which, he believed, came from the Cromer Forest beds. In December of the same year, M. Capitan wrote in *Savoir* that both he and M. Breuil were prepared to accept, as of human workmanship, the flints of the Cromer Forest bed and

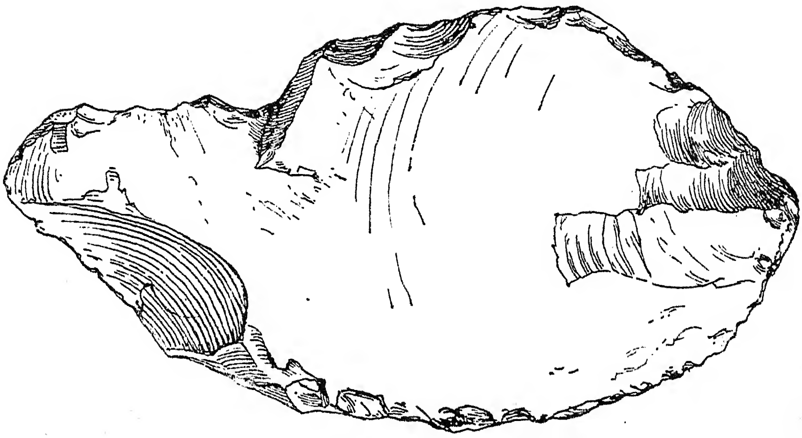

FIG. 30. Worked flint from Foxhall.

the Red Crag, including those found at the base of the Crag, as indubitable evidence of the existence of man in the Pliocene epoch. M. Boule, however, has so far declined to express a definite opinion on the subject. There are many others, not only in France, but especially in this country, who are extremely sceptical of the human workmanship of these flints.

In a letter to *Nature* in March 1924, Mr. Moir pointed out that eoliths, similar to those found on the Kentish plateaux by Mr. Benjamin Harrison, were found beneath the Red Crag, in the same layer as the rostro-carinates, but in an abraded condition. He claims, therefore, that these Kentish eoliths, and all those from similar sites, must belong to a still older age, somewhere earlier in the Pliocene.

We must now turn to the difficult problem of bringing the

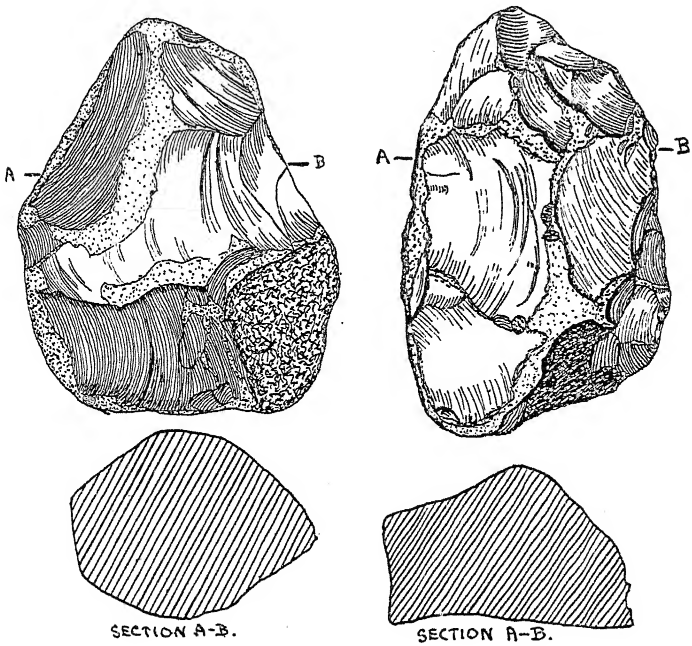

Fig. 31. Flints from the Cromer Forest bed.

different types of implements and the deposits in which they have been found into relation with the different phases of the Ice Age as set out by Penck and Brückner.

Now certain deposits in the Somme valley yield a fully developed Chellean industry, accompanied by remains of a fauna indicating a temperate climate, while above these lie two others, containing respectively early and late Acheulean implements, with evidence from the fauna that the climate was growing colder. Above these again are deposits containing Mousterian implements with a decidedly cold fauna. M. Boule, quoting some discoveries made by M. Tardy in the Ain valley, states that Acheulean implements occur overlying the moraines of the Riss glaciation, but not those of the Würm, and on these grounds the Chellean culture was placed in the warmest part of the Riss-Würm interglacial period, the Acheulean following it as the climate became cooler, and the Mousterian taking its place as the Würm glaciation was approaching.

Another point of view, however, was advanced in Germany. At Taubach, near Weimar, was found a tufa, known as the Older Tuff, lying beneath a Later Tuff and above glacial gravels. The lowest deposit of the three is obviously glacial, and the fauna found in the Later Tuff betokens a period of extreme cold. On the other hand, the Older Tuff contained bones of animals requiring a milder climate, and clearly belongs to an interglacial period. In this middle layer were found implements, bearing a general resemblance to the Mousterian industry of France, though exhibiting somewhat more primitive forms. The middle layer was attributed to the warmest part of the Riss-Würm interglacial period, and the Chellean industry was relegated by most German writers to the warm Mindel-Riss interglacial period.

Thus two schools arose, and various views were advanced as to the relations between the different industries and the successive glaciations. In 1915, and again in 1918, Dr. H. Fairfield Osborn of New York put forward a scheme not unlike that favoured in France, for he relegated the pre-Chellean, Chellean, and Acheulean industries to the Riss-Würm interglacial stage, and the Mousterian to the Laufen retreat. In

1922 he had come round more to the German view, and had placed the Chellean in the Mindel-Riss interglacial phase, with the Acheulean at its close, while the warm Mousterian of Taubach he placed in the Riss-Würm interval with the cold Mousterian following as the Würm glaciation approached.

But others have pointed out recently that the Mousterian industry of Taubach is more primitive than that found in the

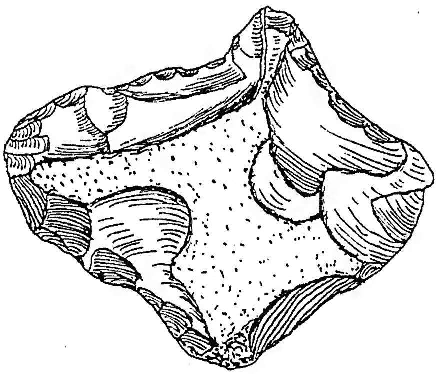

FIG. 32. Abraded Kentish eolith.

Somme valley or in the cave of Moustier, and that, while Acheulean culture is only a more advanced stage of Chellean, the Mousterian industry, which has tools made from flakes rather than from cores, indicates the arrival of a new people with a different culture. They have suggested, therefore, that the Mousterian people were dwelling near Weimar at the time when the Chellean people were occupying the valley of the Somme. Then, as the climate deteriorated with the oncoming of the Würm glaciation, the Acheulean folk, the descendants of the Chelleans, migrated southwards, and the Mousterian folk took their place.

Further examination of the Somme terraces and their contents seemed to show that the Chellean implements, which had been relegated to the Riss-Würm interglacial phase, were of a very developed type, called by the French *Chelles évolué*, while more primitive forms, also classed as Chellean, belonged

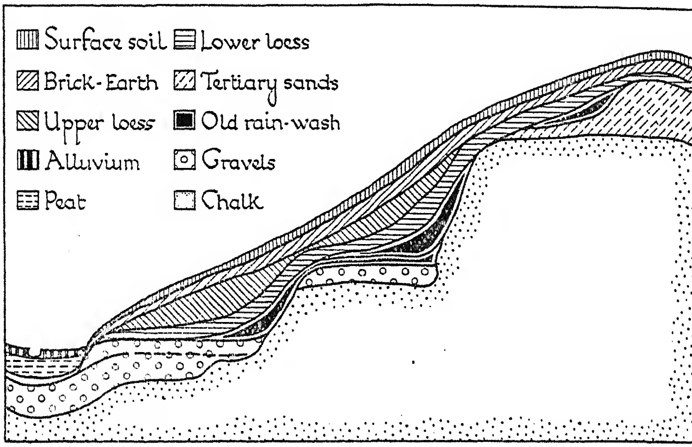

FIG. 33. The Somme terraces.

to an earlier period. As a result of this and other evidence, Professor Sollas suggested in 1923 the following scheme:

		Würm glaciation.
1st or lowest Somme terrace, 16–18 m.	Mousterian Acheulean	
	Chellean évolué	Riss-Würm.
		Riss glaciation.
2nd Somme terrace, 32 m.	Chellean (type)	Mindel-Riss.
		Mindel glaciation.
3rd Somme terrace, 56–9 m.	Pre-Chellean	Günz-Mindel.
		Günz glaciation.
4th or uppermost terrace, 103 m.	No implements	. . . .

PERIODS	BRITISH & OTHER DEPOSITS	GLACIATIONS	INDUSTRIES
PLEISTOCENE		WÜRM II	
		Laufen retreat	
	Hessle boulder-clay Intensely Chalky boulder-clay	WÜRM I	
		Riss-Würm Inter-glacial	Lower Mousterian Acheulean Developed Chellean
	Purple boulder-clay Chalky Kimmeridgic boulder-clay	RISS	
		Mindel-Riss Interglacial	Chellean
	Basement boulder-clay Norwich brick-earth, Cromer Till North Sea drift, Contorted drift	MINDEL	
	Cromer Forest beds	Günz-Mindel Inter-glacial	Pre-Chellean, Strépyan, Cromerian
	Weybourn Crag Chillesford beds	GÜNZ	
	Norwich Crag Red Crag		Foxhall
PLIOCENE	Coralline Crag		*Rostro-carinates*
	Lenham beds		*Kentian Eoliths*
MIOCENE	PONTIAN		*Cantal Eoliths*
	SARMATIAN		
	HELVETIAN		
	BURDIGALIAN		

Fig. 34. Chart, showing the phases of the Ice Age correlated with Eolithic, Early and middle Palaeolithic industries

Note. The chart reads, in order of time, from the bottom upwards

Obermaier, as early as 1906, showed from an examination of the Garonne terraces that the Mousterian culture not only preceded but immediately followed the last glaciation, or, as he succinctly phrased it, the Mousterian straddles the Würm.

This scheme, as outlined by Professor Sollas, coincides absolutely with the evidence cited from the pit in Foxhall

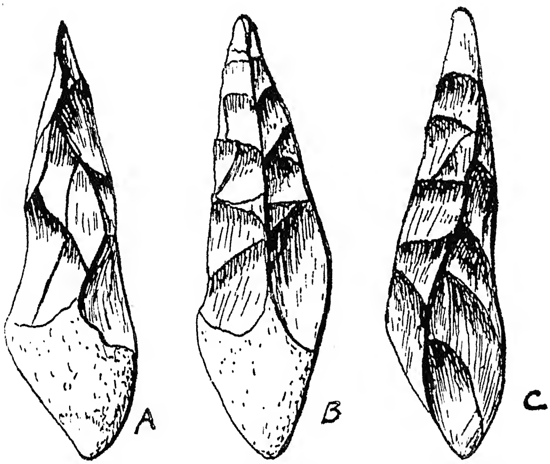

FIG. 35. Pre-Chellean, Chellean, and developed Chellean.

Road, Ipswich, by Mr. Moir, if we assume that the three glaciations noted by Professor Boswell are the last three of Penck and Brückner, and that the period of the Günz glaciation gave Britain the Weybourn Crag, indicating very cold conditions, but not an ice sheet. This view is by no means generally accepted, though it appears to the authors to be the most acceptable scheme yet advanced, and, if we may include all the Pre-Chellean industries, the human origin of some of which we are not yet prepared to accept, the following chart

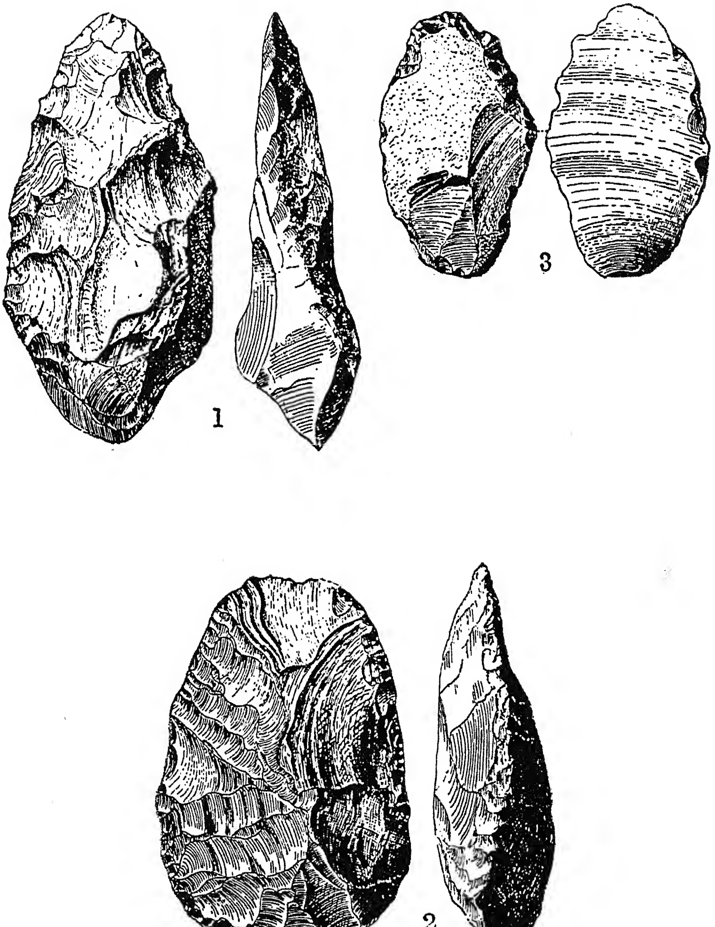

FIG. 36. Acheulean implements.

seems to indicate the solution which at the moment seems to us the most probable. As this goes to press we hear that the Abbé Breuil has advanced a view that the Mousterian industry in Western Europe began at the close of the Mindel-Riss interglacial phase, and continued until the Würm glaciation was passing away. If this view wins favour, the Acheulean and Chellean phases must be moved back one stage.

It remains now only to give a brief description of the industries which have been mentioned, but as a full description in words conveys but a slight impression to those who have not seen the specimens themselves, and is superfluous for those who have, a few words only will be devoted to the salient features, and readers are referred for a fuller appreciation of their forms to the accompanying illustrations, or to those in the *British Museum Guide* to the Stone Age; better still will it be to consult the many representative collections which are to be found in most of our more important museums.

Eoliths are flat pieces of flint, often of tabular flint, the edges of which have been flaked, often so as to produce semicircular notches. Their forms are very varied, and seem to have been fashioned on no particular design. Those from the British deposits are usually a deep ochreous brown, while those from Cantal are not; the latter differ from the former also in shape.

Rostro-carinates are large flints with a kind of hooked beak at one end and a keel running the whole length of the object; they, too, are usually stained with an ochreous glassy patina.

The Foxhall flints are of different types, small flakes and borers predominating; their surfaces are white, porcellaneous, and lustrous.

The pre-Chellean, typical Chellean, and developed Chellean implements are all of the same general type, though they differ in size and in the finish of their workmanship. In the earlier

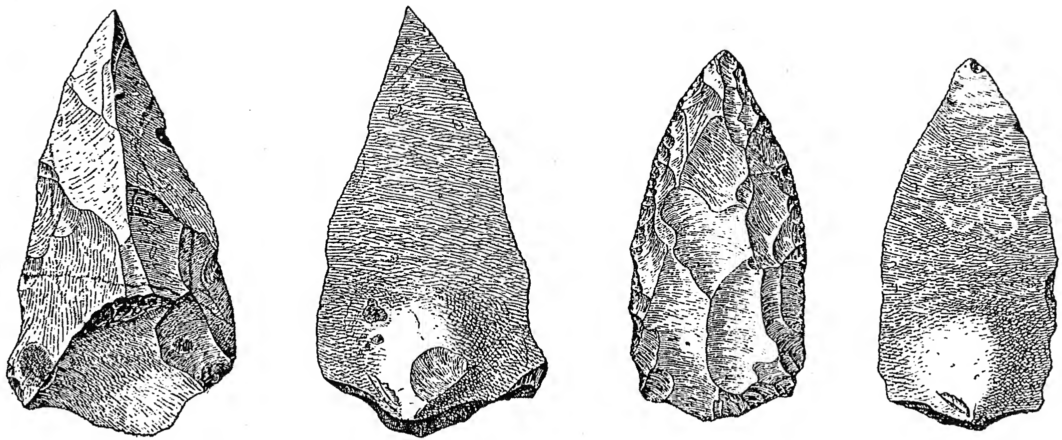

Fig. 37. Mousterian implements. From G. and A. de Mortillet, *Musée préhistorique*.

specimens much of the original crust of the flint is left on the base or butt of the implement; this becomes less in the later specimens, and disappears altogether in the developed types.

The Acheulean implements are a further development of the Chellean; the specimens become thinner and flatter, and the flakes smaller than in the earlier types.

The great majority of the above implements, with the exceptions of the eoliths, may be considered as various stages in the evolution of two types of tools, which are essentially shaped cores. This evolution reaches its culmination in Europe in the late Acheulean period, though specimens showing a still more advanced technique have lately been found by M. Regass near Tebessa, on the northern borders of the Sahara desert. These are all 'core implements', that is to say, tools made by striking away flakes from the original flint until the desired shape has been achieved. A few 'flaked implements' occur, however, from Chellean times onwards, and become more numerous with the appearance of what is known as the 'Levallois flake', towards the close of the Acheulean period.

The Mousterian implements, on the other hand, are flakes, and have been made by shaping the tool on the side of the flint block, and then striking off the desired portion with one sharp blow. This results in one side being flat; the edges of the other side are often retouched by striking off small flakes. A few 'core implements' are found, however, in Mousterian deposits.

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7

The Early Types of Man

In chapter 4 we described in outline some of the changes involved in the development of the physical characters of mankind. We noted especially the growth of the brain, the diminution of jaws and teeth, the assumption of a more upright posture with related alteration of the foot from a grasping organ to a support or base, and the loss of hair ; one might add to these a decrease in the thickness of several bones partly connected with the diminution of the jaws and their muscles. Fossil remains of early man are, unfortunately, very rare, as are those of the higher apes ; we are, therefore, unable to make a detailed picture of human evolution as yet. But when it is realized that several of the most important fossils of man have been found within the last generation, we may hope for considerable additions to our knowledge when exploration has been continued, especially in Africa and Asia. The discovery at Broken Hill in Rhodesia, and that of two human teeth with fused roots in a Lower Pleistocene, or possibly even earlier, deposit in a cave at Chow Kou Tien, 40 kms. S.W. of Peking, are of great importance.

In studying human, and possibly pre-human fossils, we need to bear in mind that we are not following out one simple line of descent from the earliest type to modern man. On the contrary, we seem to have in *Pithecanthropus* a side-branch of the evolutionary tree, a type that shows resemblances to man in some details, but in others peculiarities which put it out of court as a claimant for a place in the ancestry of modern man. Similarly, the Neanderthal race, to which, in the broad sense, so many of the known human fossils belong, has some special features such that its relation to modern man is at the best very doubtful.

The study of human fossils brings out increasingly the truth of Elliot Smith's simple but brilliant diagnosis of the brow ridges as an important feature in the classification of man. Whatever the sex or age of the Piltdown specimen, it represents a type with poor development of the brow-ridges, whereas *Pithecanthropus* and the Neanderthal race show them enormously developed. Among modern men they are notably weak in several, but not in all, African peoples, but they are fairly strong in various other parts of the world, though nowhere do they now approach the strength found in the Neanderthal race.

All the specimens associated in any way with the early history of man have brains larger than those of apes, and this establishes Elliot Smith's doctrine that the brain led the way in human evolution. All except Piltdown show, so far as their jaws are known, that the canine teeth, unlike those of apes, do not stand out much above the rest; so this reduction of canines was probably a very early feature of human development. Few, if any, walked fully erect, so this feature was acquired relatively late.

At Trinil, in Java, were found in 1890–4 the covering of a brain-case, a thigh-bone (*femur*), and three teeth; it is generally allowed that these belonged to one individual, though this is not certain. It is said that a fragment of a lower jaw was found later on. Much trouble has been taken to date the deposit in which the remains occurred, but it is still diversely diagnosed as either Upper Pliocene or Lower Pleistocene. It has, at any rate, some claim to be the oldest deposit in which bony remains approaching human type have been found.

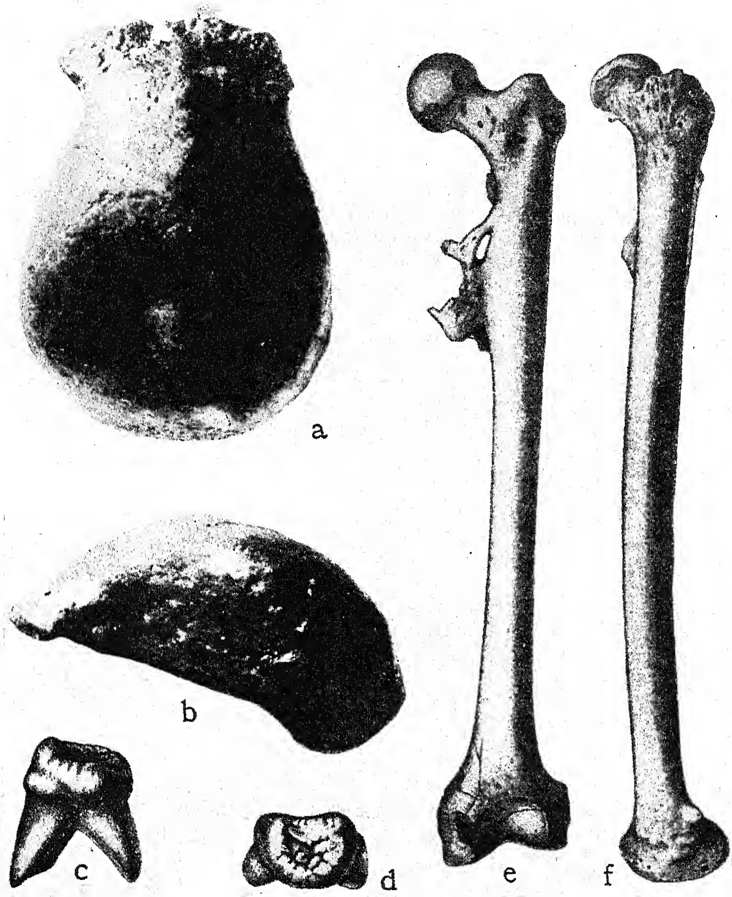

FIG. 38. *a, b, c, d*, Calvarium of *Pithecanthropus erectus*; *e, f*, Femur of *Pithecanthropus erectus*. (After Dubois.)

The femur is remarkably straight, and if its possessor was of human proportions, he probably stood 169 or 170 centimetres high, or about 5 feet 6½ inches. The straightness of the bone suggests an erect posture, but, if one were reconstructing the complete skull from the skull-cap, one would hardly make it such that it would be carried in what we call the erect position. This consideration must not be allowed too much weight, as reconstruction is difficult in any case, and doubly so when we are dealing with a type about which we know so little. Much has been said about an abnormal growth on the femur, but it is doubtful whether this abnormality means much. It has also been noted that the shape of the bone in section is not that characteristic of most of mankind, but some workers would not go so far as to say that it is clearly non-human.

One of the teeth is generally thought to have belonged to an old person, the others probably to a younger one. They are larger than the teeth of Europeans, but not much larger than those of Australians; they have a good many ape-like features and long divergent roots.

The skull-cap shows a low and extraordinarily narrow frontal region with a very weakly marked median crest. The arrangements for the attachment of the temporal or jaw muscles suggest that those muscles were much weaker than in the apes. The back end of the skull suggests a condition intermediate between that of apes and that of mankind. A crest along the side of the skull-cap towards the back is more ape-like than human. The total length of the skull would be about 185 mm., and the breadth 135 mm., or 72·5 to 73 per cent. of the length. This percentage is called the cephalic index, and when it falls under 75 per cent., the skull is said to be long or dolichocephalic. The Java specimen, usually known as *Pithecanthropus erectus*, would thus nominally fall into the long group. This, however, hardly gives a fair basis for comparison with modern skulls, since here 23 mm. of the length is merely the thickness of the enormous brow-ridge, which is continuous from side to side. The brain-case proper, therefore, inclines rather towards the short and broad condition. The breadth of the forehead just behind the great brow-ridges is only 84 mm., a very unusually low figure. It is probable that the cubic capacity of the brain case, if completed, would be something below 950 cubic centimetres, approximately the lowest level reached among mankind; but nowhere else among mankind, fossil or recent, do we find a forehead as low as that of this specimen. Elliot Smith has made a study of the internal surface of the skull, and has been able to draw the inference that 'there was already a noteworthy and highly significant overgrowth of the area of its cerebral cortex corresponding to that part of the modern human brain, interference with which leads to a disturbance or a loss of the power of appreciating the meaning of the arbitrary auditory symbols of spoken language'. Elliot Smith urges with great force that this is evidence of the earliness of the use of complex vocal sounds by man's forbears as a means of intercommunication.

The name *Pithecanthropus* is given as an indication of the intermediacy of this specimen between the apes and man, and the specific name *erectus* is added because if the specimen was nearly man, his thigh bone indicates an erect posture. The alternative rather improbable suggestion has been made that we are here dealing with a relative of the gibbon ape, showing special developments somewhat parallel to those of mankind, not with a close relative of mankind at all.

We shall probably not go far wrong if we draw the conclusion from Elliot Smith's statements that *Pithecanthropus* was a creature, social in habits, with a power far beyond that of animals of communicating his experiences. This feature may well be one of the fundamental characteristics of mankind. The large size of the brain-case as compared with that of the apes is important in this connexion.

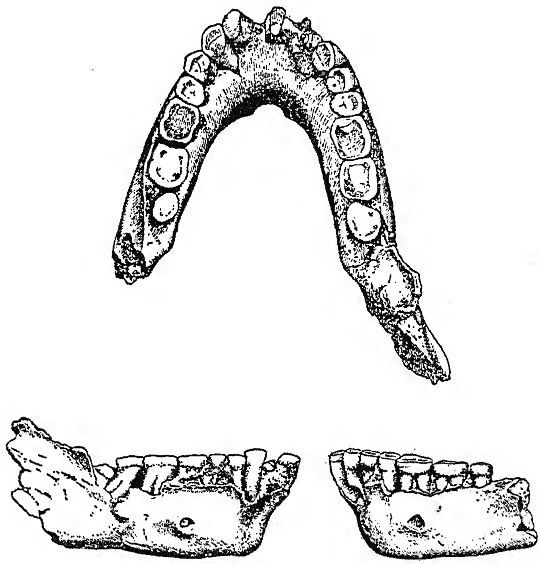

FIG. 39. The Ehringsdorf jaw.

The remains which come next in point of age are a lower jaw found at Mauer, near Heidelberg, two molar teeth from Taubach, near Weimar, a part of a lower jaw, and a child's lower jaw from Ehringsdorf, near Weimar, all in Germany, and portions of two skulls, one lower jaw, and a tooth from Piltdown, Sussex, in England. Little can be gained by discussion of the relative ages of these few fossils, which are all from the Lower Pleistocene, though it is widely held that the German specimens are rather older than the English.

The Taubach molar teeth are larger than those of ordinary men, and have somewhat ape-like cusps. The Ehringsdorf jaw, or Weimar jaw, as it is often called, is much mutilated. The symphysis or junction between the two sides slopes backwards

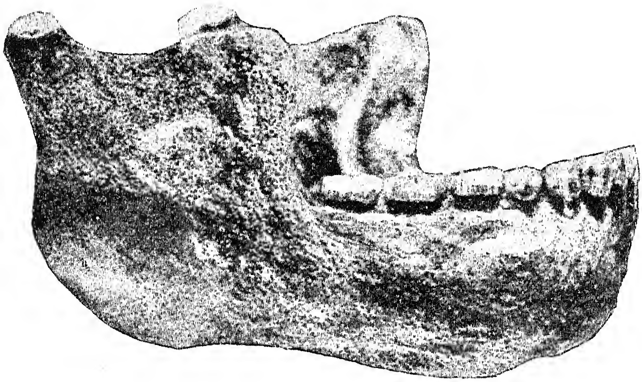

FIG. 40. The Mauer jaw.

and is ape-like in form; there is no chin. On the whole, the jaw approaches that of the Neanderthal type, to be discussed below. The last molar tooth in this specimen is small, as in many men, which is a surprising feature in so ancient a specimen. There is some doubt as to the age of this specimen, which may belong to the very end of the Lower Pleistocene. In the child's lower jaw the teeth project less, but the general characters are similar, save that the last molar is not reduced. In the child's jaw the canine teeth seem not to have been very large, but they may have been fairly large in the jaw of the adult.

The Mauer lower jaw is one of the most famous of all known remains of early man, and the specimen to which it belonged has been named *Homo Heidelbergensis*. With the specimen were found remains of animals which help to date the deposit as very early Pleistocene. The jaw is almost complete, and shows remarkable proportions. The upward projection at the back of the jaw is massive and almost square, and not very near either that of the chimpanzee or that of modern man, though a little nearer that of the Neanderthal types. As in apes and most of the very early men, there is no chin, and the symphysis, or junction between the two sides, is more ape-like than those of other men, though already well removed from the ape condition. Most men possess certain tubercles on the lower part of the inner side of the jaw near the junction of the two sides; these serve for the attachment of some muscles of the tongue. The Mauer jaw has in the place of this a distinct hollow, such as is found in apes. In this and in other respects the Mauer jaw shows that its possessor could not use his tongue as freely as we do, and may have spoken comparatively little, though as even *Pithecanthropus* shows evidence of some powers of speech, we must not exaggerate this point.

The teeth though strong are very human and the canine tooth did not stand out nor was it separated by a gap or diastema from the next one behind it. The last molar tooth is not reduced. The molars all have five cusps, but the cusp farthest back does not stand out as in the apes. In general the teeth show resemblances to those of some present-day types with large jaws like the Australians.

The finds at Piltdown in Sussex have aroused the greatest interest. First of all in the early years of this century fragments of human bone were found which Sir A. Smith Woodward recognized as parts of an ancient and peculiar skull; with them was the right side of a lower jaw. There were also bones of animals and some chipped flints. In 1913 a canine tooth was found at about the same place. In 1915 about two miles away were found more skull fragments and a tooth.

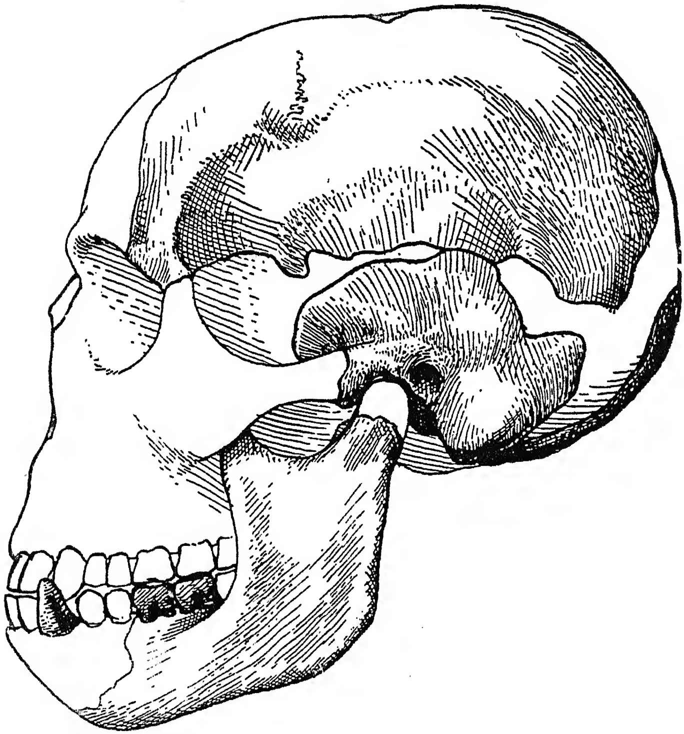

FIG. 41. The Piltdown skull. Drawn from Professor John I. Hunter's reconstruction by L. T. Poulton.

Before the last-mentioned find was made it was supposed by some Continental and American workers that the lower jaw first found did not belong to the same individual as the skull fragments, since the jaw is very ape-like and the skull very human. But there is the same diversity of character, so far as can be inferred, in the second group of finds, and the occurrence of the same combination twice makes it almost certainly a natural one, so nearly every one now believes with Smith Woodward, Elliot Smith, and Keith that skull and jaw belong to the same type.

The symphysis or union of the two sides of the lower jaw, if rightly reconstructed, is very ape-like; it appears to have sloped backward even more than that of the Mauer jaw. The reconstruction is, however, not universally accepted. The upward projection at the back of the jaw is broad but in detail a little more in line with that of ordinary man than is that of the Mauer jaw. The molar teeth all have five cusps and the cusp farthest back projects almost like that of an ape. The third molar has not been found. The canine tooth is so large that it must have projected above the level of the other teeth. The jaw is thus more ape-like than human and much more ape-like than the Mauer jaw.

Only fragments of the skull were saved and it has been found difficult to make certain of the way in which they should be set together. The difficulties have been reduced after much discussion and a skull has been built up with a brain-case of cubic capacity of about 1,300 cubic centimetres, quite a reasonable human measurement. There is no doubt that the skull by itself, that is without the jaw, is very distinctly human, and shows some resemblances to the skulls of men of much later date, reserve being made for the extreme thickness of the bone in this case. A brain-case with a capacity of 1,300 c.cm. is common among Australian natives and other lower races, and we thus have a fully human brain already at this early stage, a strong argument in favour of Elliot Smith's long sustained contention that the brain led the way in human evolution.

The latest reconstruction by Elliot Smith and Hunter shows the occipital or back region of the skull to have been a little more like that of a young ape than had been supposed, and correspondingly a little less human. Nevertheless it is generally agreed that we have here a head nearer to that of modern man than to that of the Neanderthal type, which we have to consider next, strangely associated with a very ape-like jaw. The skull must have been fairly high, of medium breadth, and without brow-ridges. The last-mentioned fact has led to the suggestion that it belonged to a woman. Whether this be the case or not it clearly indicates that brow-ridges were by no means universal among early types any more than they are among modern races, for many modern African types lack them completely. One should add that nasal bones of human type were found with the skull fragments.

The indications from the specimens thus far considered point very clearly to the evolution of the human skull and brain as an earlier chapter of history than the full evolution of human jaws; they also point to the complexity of the history. We are far from having one clear line of descent; there must have been several special developments side by side and successively, and now one, now another feature seems to show parallelism to or kinship with humanity.

We now come to a remarkable series of specimens generally found in deposits a little younger than those containing the above and classed as Middle Pleistocene. These specimens have been discovered in the following places: Gibraltar, Neanderthal, La Naulette, Spy, Malarnaud, Krapina, La Chapelle-aux-Saints, Le Moustier, La Ferrassie, La Quina, and as regards teeth only, in Malta and Jersey. Krapina is in Croatia and Neanderthal is near Bonn, but the other sites are in south-west Europe, mainly in central and southern France.

Mention should also be made of a supposed human *sacrum* which falls into this series and was found in the loess in the province of Honan in China, as well as of the Broken Hill skull from Rhodesia, though the latter is generally supposed to be much later in date than the Pleistocene.

This series of specimens has settled once and for all the old controversy as to whether the Neanderthal skull was an indication of some diseased condition or abnormality; it is now accepted by every one that there were men of the types to be described. Until the Broken Hill skull came to light it was widely held that the Neanderthal types vanished without a trace soon after the Middle Pleistocene period, but now we have indications that they survived in South Africa at least. It has been widely held that *Homo neanderthalensis* has not transmitted any physical features to modern man, but that conclusion must be put in suspense again in view of the Rhodesian find; our ignorance of Africa is unfortunately still very profound.

The series has received the collective name of the Neanderthal race, but it should be understood that its specimens are by no means uniform. The Gibraltar skull is peculiar in many ways and may be considered lowlier than the rest. The name, Neanderthal race, is a little unfortunate as matters now stand, as it is associated with an individual of whom only the skull-cap and the long bones are preserved. The best preserved specimen is that from La Chapelle-aux-Saints, to which Boule devoted a monumental work.

Of characters that seem to have been possessed by most of these types of the Middle Pleistocene, we note first and foremost the possession of an immense ridge composed of the strongly developed brows and of the glabella or ridge above the root of the nose. Some other types, ancient and modern, have large brow-ridges, and a strong glabella, but one can usually distinguish the separateness of these various elements, whereas in the Neanderthal types they all unite in one great bar often called the frontal *torus*. The forehead is very much inclined, though less so than in *Pithecanthropus*, the back of the skull projects out strongly and is, as it were, pressed down.

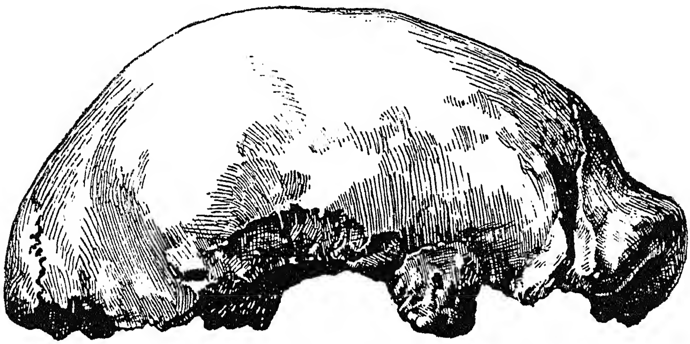

FIG. 42. Drawing of the right side of the Neanderthal skull by T. L. Poulton.

The brain-case is large, but the brain was of lowly type. The orbits are very large and round and the nose large and prominent. The face is rather long and projects far forwards as compared with that of modern man; in fact there is still something of a snout. The cheek bones recede rather than project laterally. The lower jaw is strong with a large upward projection at the back. The chin is undeveloped. The teeth are very strong and have many primitive features. The legs are relatively short compared with those of modern man and the type did not walk quite erect. It will be seen from the above description that the material available is far more abundant than it was for earlier types. The proportions of arms and legs are more human than ape-like, though not quite of modern type.

The Gibraltar skull is said to be that of a woman and its relatively huge facial development and very large eyes are remarkable features. It is generally thought to be lowlier than most of the others.

The specimen from La Chapelle-aux-Saints has become a classic subject and indeed throughout this short study of Middle Pleistocene man we are necessarily indebted at every step to the work of Boule, supplemented in some important directions by Elliot Smith and Keith. The man of La Chapelle-aux-Saints stood less than 160 centimetres or 5 feet 3¼ inches high, yet he had a very large and heavy skull, which he was obviously unable to hold quite erect. The face was large and projected farther in front of the brain-case than does that of modern man, but nothing like as far as that of the apes. In this respect the race we are studying had clearly gone a long way towards what we may call human standards. In the matter of brain-case and brain, however, the race is more truly at a half-way stage between the two. This has given rise to the view that the race, after sharing in common with other human races the first steps in the direction of snout reduction and brain growth, diverged from the main human stem through the slowing down, if not indeed the arrest, of the latter process at a certain stage.

The position and shape of the *foramen magnum*, the opening at which the brain and spinal cord are joined, in the skull from La Chapelle-aux-Saints is intermediate between that in the apes and that in man generally, and clearly shows that the type was not yet able to stand quite upright. The whole apparatus of the upper jaw is still projected forwards rather in the ape fashion, and this affects deeply the cheek bones and the sides of the skull.

The lower jaw has been more thoroughly studied than those of most other specimens known to have belonged to this race. It suggests relationships with the Mauer jaw on the one hand and with that of later man on the other. The bite was of much more rounded outline than in any later men, though these differ markedly among themselves. The upper and

FIG. 43. The skull of La Chapelle-aux-Saints.
(After Boule, *L'Anthropologie.*)

lower teeth bit against one another, edge to edge, even in front, as they still do in some modern types. Apparently the race chewed partly by moving the large lower jaw forward against the upper jaw as also by moving the jaws from side to side. The canine teeth do not exceed the others in height, the teeth show heavy wear but have abundant space in the large jaw. They are very clearly human and the contrast with the Piltdown jaw is most marked. The Mauer jaw is not so dissimilar as far as teeth are concerned, though its form is so special. Teeth from Jersey and Malta, thought by some anthropologists to be Neanderthaloid, show a special feature in the fusion of their roots, a feature found at Krapina ; this apparently is not general among the types of this race and the condition occurs in more modern types.

The backbone shows many ape-like features in detail. Notably, the curvature of the neck to form a concavity backwards must have been almost absent. It is a human feature connected with the holding of the head upright and it is not found in the apes. The limb bones again show many reminiscences of the ape. The hip-girdle is still without the full development of the basin form which it possesses in man, in whom it is used as a support for the abdominal organs, which with the vertical posture come to lie directly above it. The *femora* or thigh bones are curved, and like the hip-girdle, backbone, and skull indicate that the erect posture was not attained. The foot shows that it was used differently from that of later man. Its outer edge supported the body weight and so the fibula or outer bone of the leg had to be strongly built. This feature is ape-like but is found in a few types of later man.

The brain was very lowly in many particulars, though it was larger than in the earlier types, for the brain-case has a capacity of 1,450 cubic centimetres. The skull, allowance being made for the great brow-ridge, was not specially long, indeed the relation of breadth to length would be considered medium, being 78 per cent. or thereabouts. This fact is of some importance for later reference.

We cannot leave this subject without special mention of the Broken Hill skull, though it is probably of much later date. It is in some ways lowlier even than the Gibraltar skull. The face was enormous and snout-like, but unfortunately the lower jaw is missing, the teeth are of the normal human type and show signs of decay. On the other hand the brain was smaller and lowlier than that of the man of La Chapelle-aux-Saints. Dubois thinks the Broken Hill skull is less related to the man of

La Chapelle-aux-Saints than to the skulls discovered at Talgai in Queensland and Wadjak in Java, which seem to foreshadow the modern Australian races. There the matter must stand for the present.

Quite recently facts concerning three more skulls have

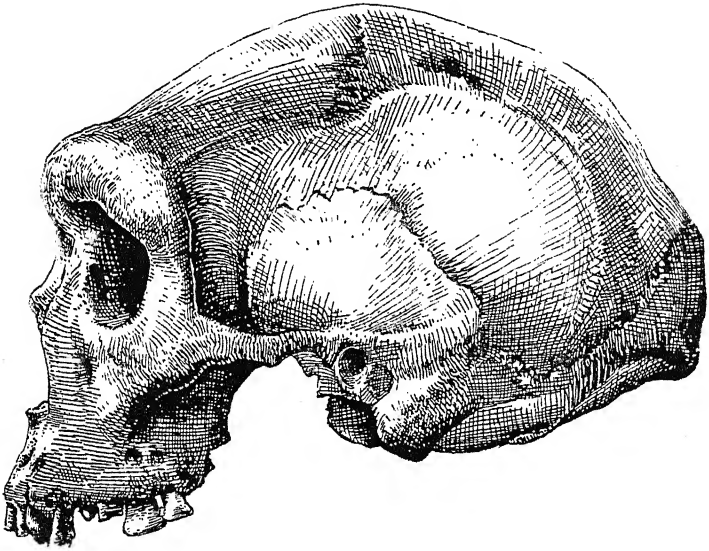

FIG. 44. Left side of Rhodesian skull. Drawn by T. L. Poulton.

become available. A skull from the Robbers' Cave near the Plain of Gennesaret, in Galilee, shows very strongly developed brow-ridges and a receding forehead; these and other detail characters link it with the Neanderthal group, but it should be noted that the two brow-ridges are separate or in other words the glabella is not so strong as it is in the Neanderthal group. The height of the skull is undoubtedly greater than in other individuals of that type, and the sides of the skull, therefore, slope down more steeply, with the result that the skull is narrower. It is probably that of a fairly young woman. Implements of an early Mousterian type were found in association with the skull; these more nearly resemble some from Africa than those of European origin.

While clearing for the foundations of the new Lloyd's building in Lombard Street in the City of London, portions of the skull of a woman of 40–50 years were found in 'blue clay' underlying a bed of gravel; the remains lay at a depth of 42 feet below the street, which means less than 20 feet above the river. Unfortunately the forehead region is missing but there seems no reason to doubt that the skull had a low vault and was lowly in type, though not so thick as most skulls of ancient types of man. It would appear that these remains were found below the third or lowest terrace of the Thames, but before drawing any conclusion as to their date it is well to remember that they must have been deposited in the bed of the river some time before this gravel was laid down. The skull is said by Elliot Smith to be much like those of women of Neanderthal type from Gibraltar and La Quina.

On the slope of a terrace 15 metres above the river Podkoumok near Piatigorsk in the Caucasus have been found portions of a skull and lower jaw together with a fragment of the left shoulder bone and some other small bones. The sex of the individual is not certain, but the general slenderness suggests a female. The comparative steepness of the forehead and the flatness of the vertex support this conclusion, though the eye sockets were far apart and the brow-ridges enormously developed. The person was probably over 50 years of age, the brow-ridges were connected by a strong glabella and above the projection due to these features jointly ran a depression, as in many specimens of ancient types of man. There seems no doubt that the skull belongs to the Neanderthal group and that it may be attributed to the period of the last glaciation of the Caucasus. Since the above was written we have received information that Miss Garrod has found another skull at Gibraltar, apparently of Neanderthal type, in association with Mousterian implements. It is agreed that this belonged to a child, probably of ten years of age.

Reviewing these ancient skulls we note that in the ape's skull from Taungs the *foramen magnum* is still far back; we do not know its position in *Pithecanthropus*. In the others it has moved further forwards on the under surface of the skull, though not as yet nearly so far as in modern man. This change is related, amongst other things, to the assumption of the erect position.

An important ductless gland called the Pituitary body occurs in the base of the skull in vertebrates. In man it is small, but an occasional individual has a large one. This condition is associated with various unusual features of growth. From this it has been inferred that the Pituitary Body has special influence in promoting growth of the jaws and the face generally as well as in determining the shape of the head. As we pass from the apes to man and from the lowliest of fossil men towards modern types we find that the *foramen magnum*, at first far back, pushes forward until the skull is so placed as to rest on the end of the backbone. This pushing forwards has shortened and altered the skull base, and apparently in consequence of this, as well as for other reasons, the pituitary body has been pressed upon and its activity reduced. This should be borne in mind as one factor of the reduction of the snout which is so marked a feature of the evolution of man.

It is probable that further discoveries of young specimens could help more than almost anything else to illuminate human evolution, but we also need further specimens of mid-Pleistocene man from regions other than those apparently then occupied by the Neanderthal race. They might help us to understand the development of modern types of man; of this we have so far only slight clues from Piltdown and perhaps in some points from the Broken Hill skulls, if we accept the general modern view that the Neanderthal type is not ancestral to the races of the present day.

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8

Chronological Summary

Let us now recapitulate some of the conclusions at which we have arrived in the former chapters. We have seen that there are good reasons for assuming that the land masses consisted of relatively light material, called 'Sial', floating on a heavier layer, consisting largely of basalt, and known as the 'Sima'.

At periodic intervals, of more than thirty millions of years, the Sial has sunk farther into the Sima, causing the oceans to transgress over the low-lying lands. Then, owing to the heat accumulated from radio-active substances the Sima has become more fluid and has expanded and the Sial has risen, causing the oceans to retreat and the crust to buckle up. Owing to this we have had recurrent phases of oceanic transgression and retreat, the latter followed by periods of mountain building, ice ages and desiccation in certain areas; these are again followed by periods of oceanic transgression.

The immense changes in environment caused by the mountain buildings and the cold periods which follow them seem to have been fatal to several of the more specialized forms of plants and animals. Only those which were in a somewhat plastic state survived, and were the progenitors of the *fauna* and *flora* of the next period.

During the time illustrated by the geological record we have evidence of several such recurrent phases. Immediately preceding the Lower Palaeozoic period, the earliest of which we have very definite evidence, a phase of mountain building had been taking place, followed, it is believed, by an Ice Age. After this came a long period of oceanic transgression, when the

Cambrian, Ordovician, and Silurian deposits were being laid down. Then, towards the end of the Silurian epoch, came another phase of mountain building, the Caledonian, which brought that period to an end. Before this time many and varied forms had appeared. During the Lower Palaeozoic period sponges, corals, and crustaceans were abundant, and some of the last named, the Trilobites, had become very highly specialized. It is only towards the close of the period, during the Silurian epoch, that we first find evidence of vertebrate animals, and primitive fish begin to make their appearance.

The Caledonian mountain building phase was followed by a desert period represented by the deposits of the Old Red Sandstone in Britain and elsewhere, after which came a period of warmth and subsidence during the Lower Carboniferous epoch, a time of oceanic transgression ; the land began slowly to emerge again in Upper Carboniferous times. This is essentially the period of fish and amphibians, and it witnessed the dying out of the Trilobites and of some other early groups. The next or Armorican period of mountain building occurred during the Permian epoch and was followed by an Ice Age ; then the desert conditions of the Triassic epoch ushered in the Mesozoic period.

During this epoch and the succeeding period of oceanic transgression which occurred during Jurassic and Cretaceous times, amphibians sank to a relatively lowly status, and the dominant lords were the reptiles, which grew to enormous size and developed elaborate armour. It is then that the first birds and the small fore-runners of the mammals appeared in humble and unspecialized forms.

Then followed the Pyrenean-Alpine-Himalayan folding, beginning in the Eocene, culminating in the Miocene epoch and dying down in decreasing pulsations almost down to our own time. Some of the uplifts in these pulsations are responsible for the phases of the Ice Age in the Pleistocene; later on, during the early part of the Holocene epoch, began that desiccation which has transformed vast areas in subtropical latitudes into the deserts that we see there to-day.

The great changes that took place in the Cretaceous epoch were fatal in the end to the large and overgrown reptiles, whose disappearance enabled the mammals to increase rapidly in numbers and in types in the Eocene epoch. Before the close of this epoch Lemurs, the lowest of the primates, had appeared, and before the mountain building had reached its maximum in the Miocene epoch, the human family had almost certainly come on the scene. Probably already during the Pliocene epoch various species or races of this family had already developed, and had spread over much of the earth.

Thus we see the periodic recurrence of phases, consisting of strains and rents of the crust with outpourings of molten basalt, followed by mountain building, glaciation and deserts; and the crises successively involved have proved fatal to the formerly dominating types. After the phase which occurred at the close of the Azoic period we find crustaceans becoming dominant, while after the Caledonian phase the important classes are fish and amphibians; again after the Armorican phase the reptiles come to the front and with the oncoming of the Alpine-Himalayan phase birds and mammals and ultimately man play the leading part. And similar lines of development may be traced among plants. Thus it would appear that times of crises have had a specially profound effect on the process of evolution, and at each crisis the leadership has been won by a group previously little specialized and not overgrown and so best able to adapt itself to a change of environment.

We are as yet uncertain as to which continent saw the rise of the first members of the human family, though we have seen reason to believe that it was somewhere in Asia or Africa that they first appeared. These early relatives of ours must have been very unlike any that we know to-day, and were almost certainly of several very divergent types. This much we can say with fair certainty; they lived on the ground, walked more or less erect, had shorter muzzles and larger brains than any of their ape kindred. Their young had a longer period of gestation and were much more helpless at birth and for some time after. Finally they used wood and stone in the place of nails and teeth, and early began to fashion implements to supplement the use of these organs.

We have seen that it is very generally believed that the Ice Age was fourfold, and that four severe periods, the Günz, Mindel, Riss, and Würm were separated from one another by three relatively mild interglacial stages. We have suggested that during the cold phases the land was elevated and the coast-line was some hundreds of fathoms lower down, while during the warm interglacial phases the sea rose some hundreds of feet above its present level. We are inclined to think of these as a series of decreasing oscillations, the last echoes of the Alpine storm.

If we are to accept as humanly fashioned all those early types of so-called implements which are collectively known as eoliths, we must admit that a creature, probably includible in the human family, in the widest sense of the term, had reached western Europe before the first symptoms of the Ice Age had begun; if we accept as humanly fashioned the Cantal flints, then he must have arrived while the mountain building was still in active progress. These views are much disputed and in any case we need not imagine that this creature at all nearly resembled man as we know him to-day, though he would have been more human in appearance and character than any of the existing anthropoid apes.

The Foxhall flints, which have been accepted as of human workmanship by a large number of archaeologists, date from a time when the climate was becoming colder as the Günz glaciation was approaching. What the beings were like who made these implements we have no idea, for no human bones have been found which can be relegated to this period. That Foxhall man was in some sense in the hunting stage can be taken for granted; that he subsisted, to some extent, upon shell-fish and the varied products of the sea-shore seems likely; and we have positive evidence that he used fire, though we cannot be sure that he knew how to make it.

The pre-Chellean implements, called by some Early Chellean, of the Günz-Mindel interglacial, the typical Chellean of the Mindel-Riss and the developed Chellean of the earlier part of the Riss-Würm are clearly different phases of the same industry, and it has been claimed that they are derived from the Rostro-carinate industry, though this is by no means agreed. It is also thought by most archaeologists that the Acheulean implements represent a further stage of the same industry, which developed as the climate was cooling on the approach of the Würm glaciation.

Of the life of the people who made them we know little or nothing. Since fire was nown to the men of Foxhall, we may presume that these men were also acquainted with its use and, in all probability, knew how to produce it. They were certainly a hunting people, as indeed were all mankind until a much later date. The frequent occurrence of their implements in what were the beds of ancient rivers and along their margins, suggests that they specially frequented such sites, where they could get water to drink and attack beasts coming down for a like purpose; they may also have added fish and molluscs to their diet. Their weapons are sometimes, though more rarely, found away from the courses of rivers, and the fact that this is of relatively rare occurrence may be due to the fact that river deposits have been better and safer sanctuaries for the preservation of these remains of the work of early man.

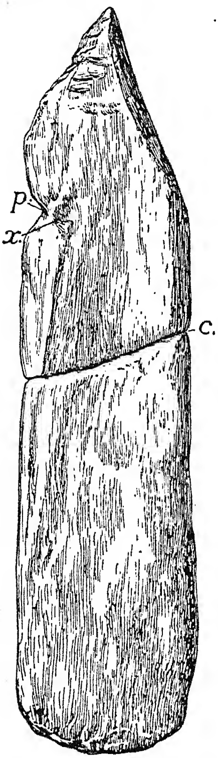

FIG. 45. Bone implement from Piltdown.

Their tools, as we have seen, were chipped from blocks of flint, and in some countries from harder crystalline rocks. Yet we must not assume that this was the only material that they used. The only wooden weapon, a spear found at Clacton-on-sea, seems to belong to a slightly later time, but at Piltdown, in the same deposit which contained the famous skull, was found an implement fashioned out of the *femur* of some ancient species of elephant, probably *E. antiquus*. The purpose of this bone implement is unknown, but the Abbé Breuil has remarked that the man who made it must have been accustomed to working in wood.

Of their habitations, if they had any, we know nothing. They probably camped in the open, like the modern Fuegians, with perhaps a rough wind-break of boughs. That they occupied the same spot for some little time is clear from the discovery of floors, where their implements were made. These have been found in the Somme valley by M. Commont and by the late Mr. Worthington Smith at Caddington in Bedfordshire.

It seems clear that this culture, though apparently one and the same in spite of the progressive stages in which we find it,

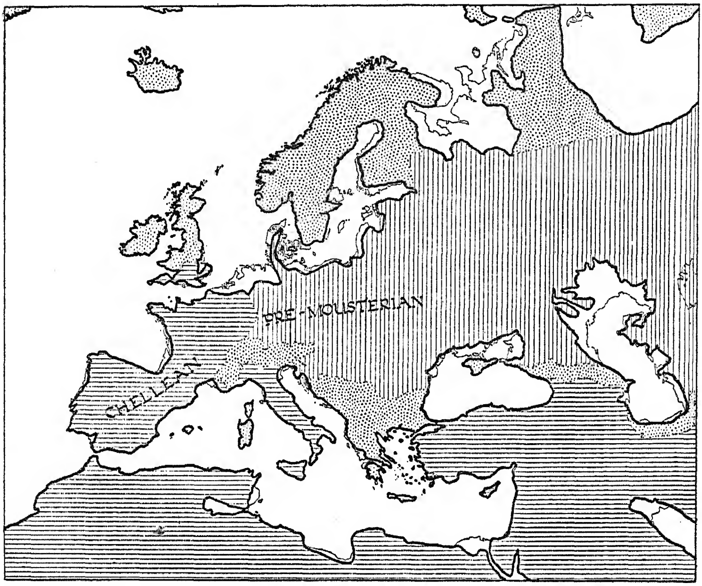

FIG. 46. Map of Europe in the Riss-Würm interglacial phase, showing the distribution of the Chellean and Early Mousterian industries.

was not the work of a single human race. Though few remains of skeletons have been found which can be relegated to the periods during which these industries flourished, such as there are exhibit very different features, for we cannot include in one type the remains from Taubach, Ehringsdorf, Mauer, and Piltdown. We must, therefore, postulate a uniform industry, evolving by slow degrees through three successive interglacial phases, and used by several very diverse types of men.

While the developed Chellean industry, followed by the Acheulean industry, flourished in western Europe, another and very different civilization existed east of the Rhine and north of the Balkans. Further evidences of this culture have recently been noted in the Caucasus. This is the Mousterian industry, which we have described in chapter 7, and which was destined to supplant the other in western Europe as the Würmian glaciation approached. This industry, as we have seen, involved a very different technique, and luckily we have ample evidence as to the physique of those who used it. Wherever the implements of this industry have been found in association with human bones, these have been of the Neanderthal type, and wherever skeletons of Neanderthal man have been found associated with implements, the latter have been of Mousterian type. So every one is now agreed that it was the Neanderthal race which was responsible for the Mousterian industry.

The distribution of this industry during the warm phase of the Riss-Würm interglacial period, shows us that Neanderthal man must have arrived in Europe from the east, probably from Northern Asia, and if the *sacrum* recently found in Honan has been rightly attributed to this race, we may speculate with some reason that the Neanderthal type of man evolved in Northern Asia.

The physical characters of Neanderthal man have been fully described in the last chapter, and his implements have been dealt with in chapter 7. We must, however, here say a little more about his culture. The wooden spear, found at Clacton-on-sea, almost certainly belongs to this culture, so we may be quite sure, in this case, that the raw materials used in his industry included wood. Bone, also, seems to have been used, though rarely, towards the close of the period, for a few slender bone points have been found in the caves of La Quina in France and of Castillo in the north of Spain.

Neanderthal man was the first, as far as we know, to take up his habitation in caves, and these he seems to have occupied during the severe conditions which obtained during the Würm glaciation. It is probable that this was no new custom of his, for the cave at Krapina, in Croatia, seems to have been inhabited by men of this type somewhat earlier in the Riss-Würm interglacial phase. It is due to this practice that we know more of his ways than of those of his predecessors. We know that he hunted and killed large animals which he used for food, and that he cooked his meat over a fire, remains of which have been found in the cave of Sirgenstein in Württemberg. It is even said of him that at Krapina he gave way to cannibal practices, presumably when the products of the chase were insufficient for his needs. We know, too, that he reverently interred his dead, on some occasions at least, for it is owing to this that we have so well preserved a skeleton from the cave of La Chapelle-aux-Saints. This was a ceremonial interment, and the corpse had been accompanied by implements, of the usual Mousterian type, and some joints of meat. Is it possible that this is evidence for a belief of early man in a future existence? Bächler in the Drachenloch, in Switzerland, and Hörmann at Petershöhle, in

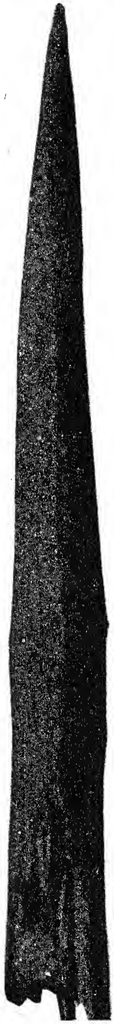

FIG. 47. Palaeolithic wooden spear.

Franconia, have found specially arranged skulls and selected long bones of the cave bear. In the former case these were placed behind low walls and the sides of the cave, and in one chamber they were set in stone cists. These seem to have been contemporary with an early phase of the Mousterian industry in Central Europe, and appear to have been some form of offering.

Some of these Neanderthal men seem to have remained in south-west Europe during the first great maximum of the Würm glaciation, taking shelter in their caves from the extreme rigours of the climate. Others seem to have migrated southwards and to have crossed over to Africa by the land bridges then existing at Gibraltar and between Sicily, Malta, and Tunis. How far south these migrated is uncertain, but implements of Mousterian type have been found in Algeria and in the Nile valley as far up as Luxor. It may be that some passed southwards to Central Africa, and survived into later days in Rhodesia.

Some, however, remained in Europe throughout the Laufen retreat and through the second or lesser maximum of the Würm, and seem to have occupied the northern shores of the Mediterranean as the ice was again passing away. But whether they came into actual contact with the modern men who arrived later, or were by them exterminated at sight as ungainly and dangerous animals, are questions that we must leave to be discussed in the next part of this series.

INDEX OF PROPER NAMES

The proper names used in Chapter I are omitted